electronics

radio, sound, communications and industrial applications of electron tubes • • • design, engineering, manufacture

New radio circuits

✦

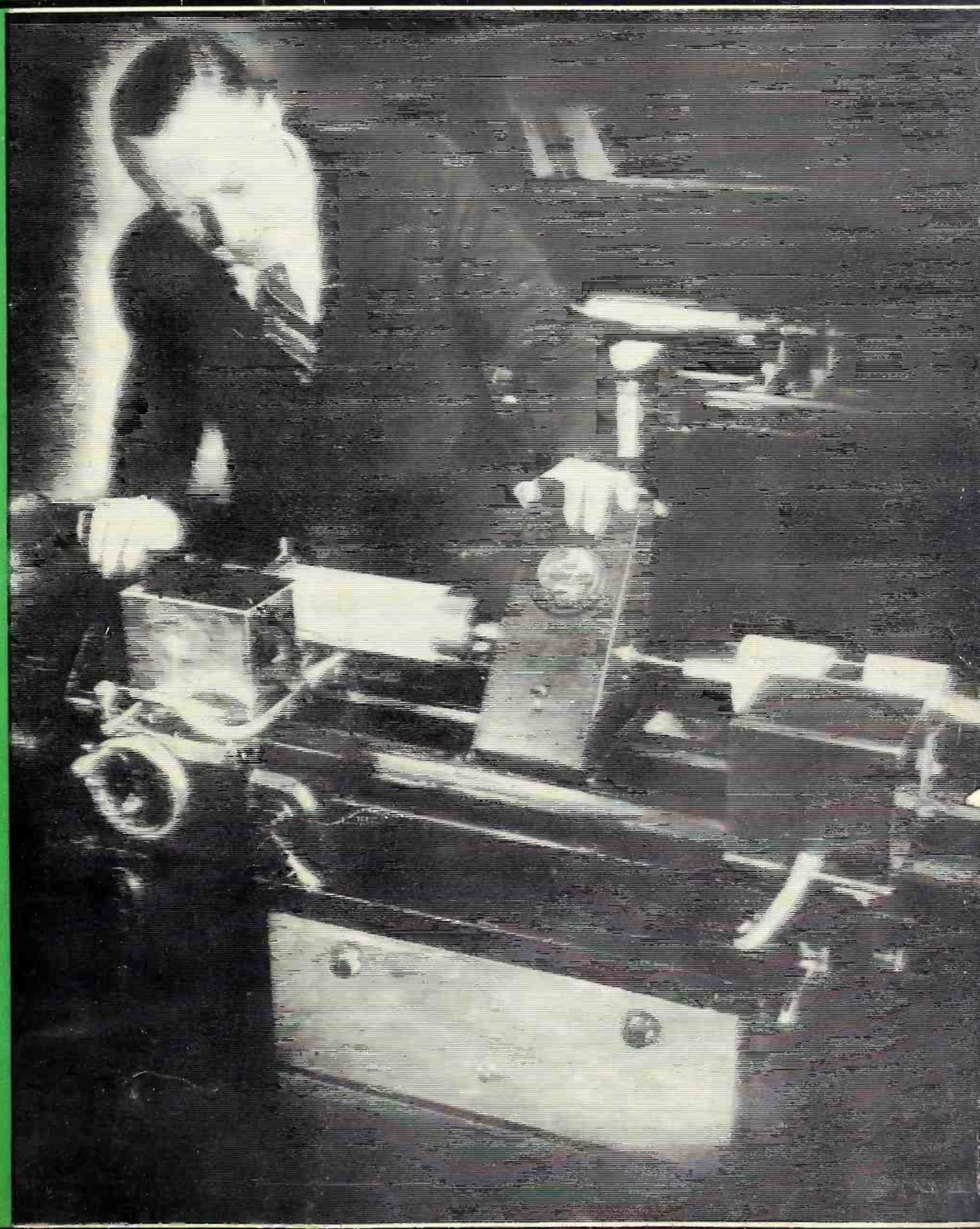
The ribbon microphone

✦

Shrinkage control in tube plants

✦

The photocell in the printing arts



At right—
Walter Howey and his new photoelectric engraver—printed from engraving made by machine itself

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

NOVEMBER 1932

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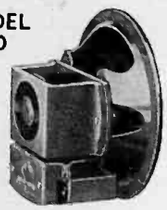
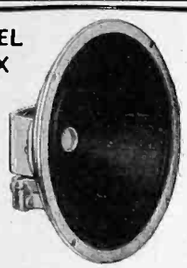
MAGNAVOX SPEAKERS and CAPACITORS

MODEL 150

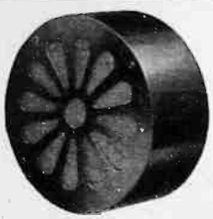


6" Dynamic Speaker

MODEL 152-X



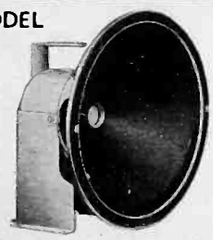
10" Dynamic Speaker



Single Stud Mounting

Model 154--8" Auto Speaker

MODEL 517



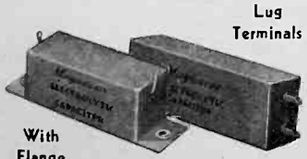
14" Dynamic For Public Address

Mershon Capacitators

Right Clamp Type

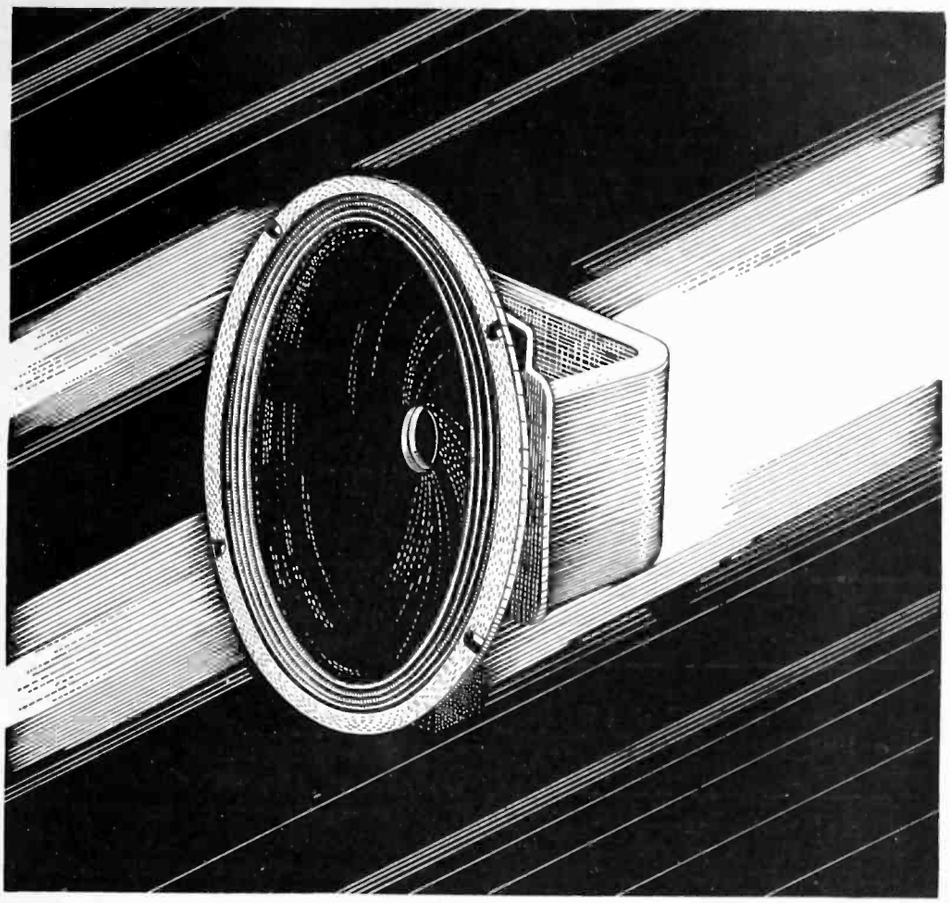
Left Stud Type Mounting

Lug Terminals



With Flange

MAGNAVOX Capacitators



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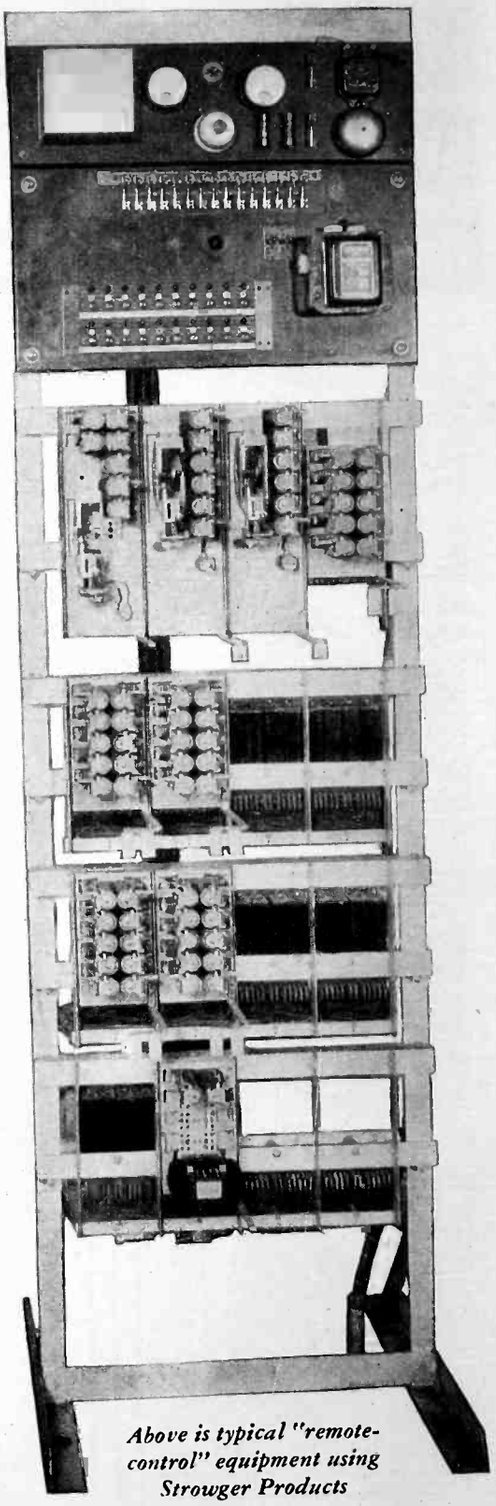

Above is typical "remote-control" equipment using Strowger Products

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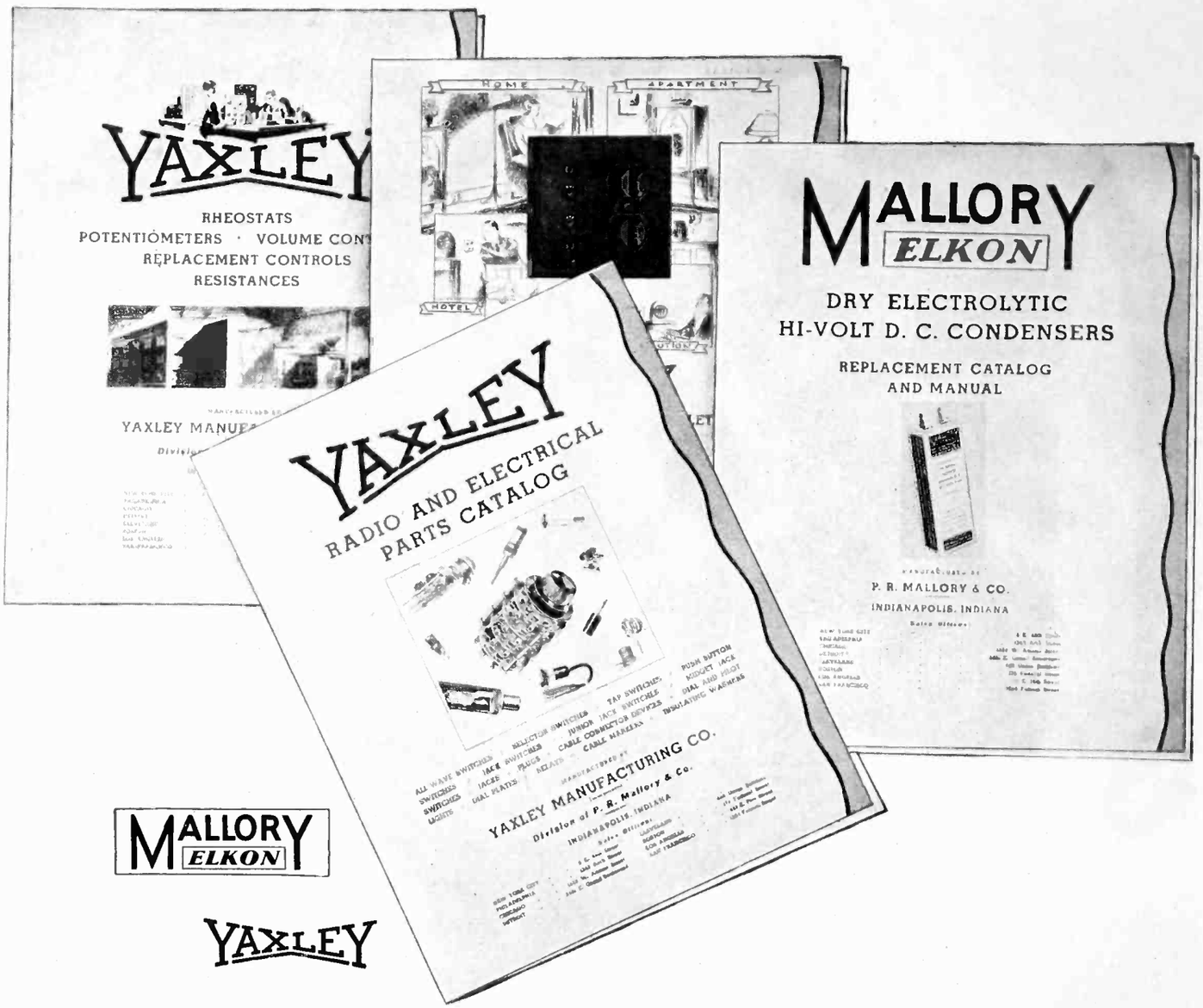

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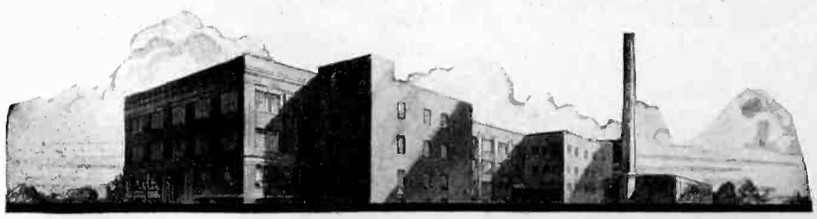

P. R. MALLORY & CO., Incorporated, INDIANAPOLIS, INDIANA

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, November, 1932

O. H. CALDWELL
Editor

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Associate Editor

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
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automatic processing
crime detection
geophysics

The Rochester Fall Meeting I.R.E.

THE Fall Meeting of the I.R.E. at Rochester, N. Y., has come to be an annual gathering of the best technical minds of the industry, important not only for the papers and discussion but because it is a felicitous occasion as well.

It is the rule of those who arrange the programs to encourage the freest discussion; for this reason the papers are forward-looking. Already many technical advances in the art have been disclosed and discussed first at these Rochester gatherings. The informality and air of expectancy, together with the excellence of the papers, unite to make the Fall Meeting an event to be looked forward to, and to be long remembered.

▼

PROGRAM—ROCHESTER FALL MEETING—NOVEMBER 14 AND 15, 1932

MONDAY 10 a.m.

- Class B Amplifiers Considered from Class A Standpoint — J. R. NELSON, Theon Mfg. Company
- New Methods of Solution of Vacuum Tube Problems — I. G. MALOFF, RCA Victor Company

MONDAY 2 p.m.

- Principles of Frequency Conversion in Superheterodynes — DAVID GRIMES and WM. S. BARDEN, RCA License Laboratory
- New Vacuum Tube Constructions — HENRY PARKER, Rogers-Majestic Corporation

MONDAY 8 p.m.

- Analogies between Radio and Photographic Techniques — B. V. K. FRENCH, United American Bosch Corporation

TUESDAY 10 a.m.

- Diode Detection Analysis — C. E. KILGOUR and J. M. GLESSNER, Crosley Radio Corporation
- Dynamotors for Automobile Radio — C. T. WALLIS, Delco Appliance Corporation
- Recent Developments in Signal Generators — LINCOLN WALSH, Consulting Engineer

TUESDAY 2 p.m.

- Modern Developments on High Vacuum Tubes — E. W. RITTER, RCA Radiotron Company
- What Do We Do Next? — KENNETH JARVIS, Zenith Mfg. Company

BANQUET TUESDAY 6 p.m.

- Radio Engineering Principles in Non-Radio Fields — A. F. VAN DYCK, Radio Corporation of America
- Radio in the Old Daze — GEORGE CLARK

INGENIOUS CIRCUITS IN

Quiet automatic volume control is a real boon to listeners

RADIO manufacturers go into a final 1932 spurt offering more technical tricks than were considered possible two years ago, and at prices which cannot be compared with those of the same period. It is true that some of these new circuits are not necessary, but neither are six-cylinder engines, four-wheel brakes or balloon tires. It is conceivable that some ultra-conservatives exist who prefer to tune a 1929 or 1930 set without benefit of *avc* or, better still, quiet *avc*, or acoustically compensated volume control, or the still-to-be announced automatic tone control—but they must be compared with those who still prefer a one-horse shay.

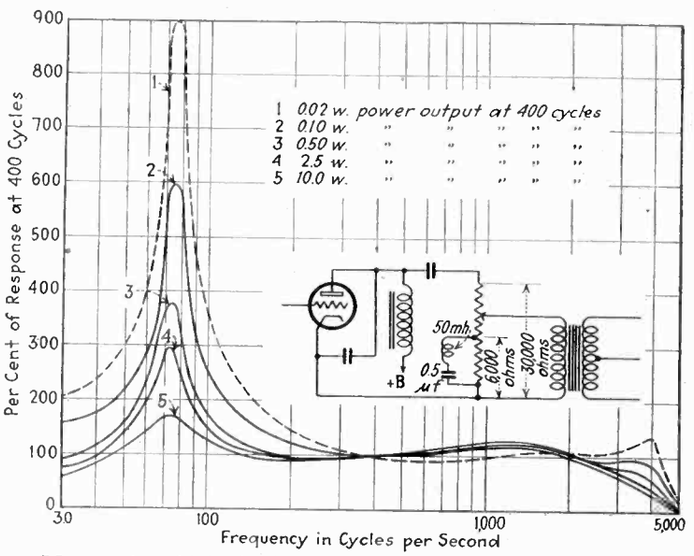
There are many sinful delights in a 1933 high-priced set ($90 or thereabouts). They will be especially valuable to the listener living not in the shadow of a broadcasting station but in places where he must reach out 100 or more miles, and where he must have 10-kc. selectivity, unfailing traps for cross modulation, and wide-range *avc*. And if the tonal range is but little improved from that existing in 1929, it is undeniably true that the owner of a modern set can enjoy what his set turns out to the fullest extent comparatively free from noise and fading.

The virtues of automatic volume control have been extolled for several years. But never has *avc* got into the $50 class, or less, which means simply that a set not having this feature will soon be obsolete. But the disadvantage of running into a batch of noise between stations makes the quiet *avc* (*qavc*) systems a positive blessing. The manner in which they work will be found described in *Electronics*, July, 1932, where the neat trick of compelling the listener to tune to the exact center of the carrier, thereby avoiding distortion, is also outlined. This is a trick which is of much more general application than was true three months ago.

Control voltages usually confined to the r.f. and i.f. amplifiers are applied to the a.f. amplifier as well in a Fada set. The control range is thereby increased so that an 86-db. variation in input to the set is held down to an 8-db. variation in output.

Acoustically compensated volume control

Putting the tone control and the volume control on the same shaft, as it were, as practiced by RCA Victor, General Electric, Zenith and others is not new in conception (see *Electronics*, August, 1930, page 230) but is newer in application. As the volume of the receiver is tuned down, the bass and high ends of the audio scale are brought up to compensate the peculiarity of the human ear that demands more and more relative power at the two frequency extremes as the volume is lowered. Defects in the speaker-cabinet system are partially overcome by this same circuit. The compensation consists of a series-resonant circuit bridged across a portion of the volume control resistor. Resonating near the center of the a.f. range, say 1,000 cycles, this circuit attenuates that region at low volumes by lowering the impedance into which the previous tube works, and in effect brings up the lows and the highs of the audio range.



Manner in which the high and low frequencies are raised in level at low volumes—the so-called acoustically compensated volume control

A typical circuit is shown together with the effect of varying the volume output within rather wide limits.

An interesting bit of engineering is contained in the method of resistance coupling a push-pull amplifier to a preceding tube in the Majestic and Columbia models. Coming out of the detector one pentode grid is connected directly through a resistance-capacity network. To get the proper phase relation (180 degrees) between the two output push-pull grids an additional tube is placed between the grid of the second pentode and the circuit which drives it. This tube changes the phase by 180 degrees and by proper design delivers the same voltage to the lower pentode as the upper tube gets directly from the previous tube. The circuit of the "phase changer" tube is shown. The two pentode grids are fed in parallel, therefore, and a 6-db. gain over a unity-ratio push-pull transformer is secured.

Another interesting method of getting proper phase relations is practiced by Capehart engineers. The first pentode is driven directly but a tap on the output transformer between the plate of the first tube and the center-tap feeds the second grid. This grid connects to the filament through a 30,000-ohm resistor and to the transformer tap through a 0.06-μf condenser. The first grid is connected to the filament through a 300,000-ohm resistor.

Although many of the present receiver models use the hybrid detector-amplifier tubes, others find the interaction between the diode plates and the triode grid sufficiently obnoxious (along with other difficulties and shortcomings) to encourage them to use two separate tubes to get their diode detector-*avc* action. A perusal of the specifications of the various sets (*Radio Retailing*, October, 1932) shows that practically every type of tube

NEW RADIO RECEIVERS

Increase in bass and high notes at low volume levels advantageous

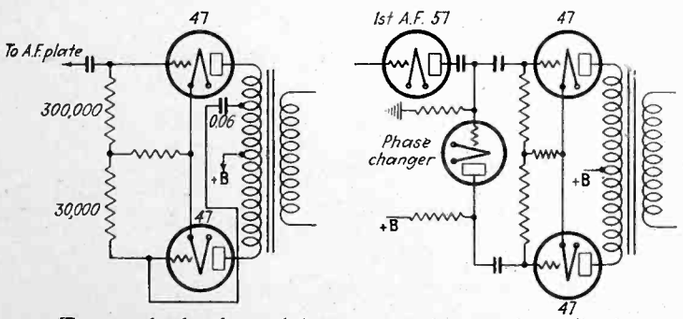
for home receivers at the present time finds its way into the second detector socket in some set or other. There is no uniformity at all in this matter.

In addition to the circuits which make it fairly simple for the set owner to correctly tune the receiver, there are visual aids in the form of tuning meters, neon lights and incandescent bulbs which change in brilliancy as the tuning proceeds through the carrier.

Of a representative group of receivers about 15 per cent used tuning meters, 10 per cent lamps of one kind or another, and the remainder used nothing at all to aid the listener.

The neon lamps require about 160 volts to strike and have a 10-volt range between striking voltage and maximum brilliance. They seem to change their characteristics with age and sets which use them have an adjustment which takes care of this variation by means of a screw-driver.

The incandescent lamps vary in output with variations in tuning by means of a saturated transformer. The circuit shown is taken from the Majestic-Columbia models. Thus the designers have adapted to radio a bit of engineering often used in illumination control. As shown in the circuit, the lamp is normally at full brilliance because the transformer is saturated by the plate



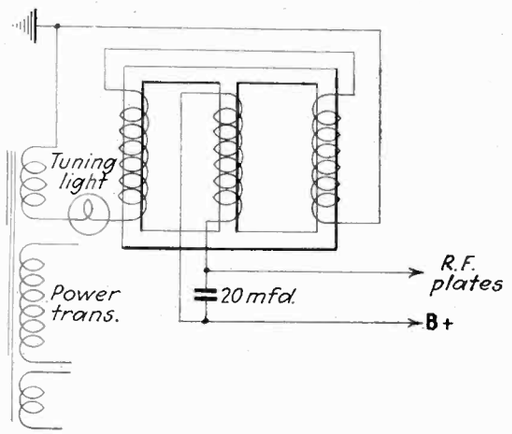
Two methods of supplying proper phase and amplitude of signal to the grids of a push-pull stage when coupled by resistance to a previous amplifier tube

current of the r.f. tubes. When the circuit is tuned to a carrier, however, the *avc* action decreases the plate current of these tubes by increasing their grid bias and this decreased current flowing through the transformer no longer saturates the core. Therefore, the impedance of the winding in which the lamp circuit is connected increases, allowing less current to flow through the lamp, decreasing its illumination.

This saturated-transformer method of aiding the tuning of the set is really an elegant circuit adaptation. Its cost is probably somewhat higher than that of the neon light. The latter costs about 90 cents to $1.35 including wiring, lamp etc.

The dollar-in-the-slot receiver

The universal d.c.-a.c. receiver made by International (Ann Arbor) is attracting much attention not only for its small size and low cost, but the ingenious scheme to



A saturated-transformer method for controlling the illumination from an incandescent lamp—in this case variations in volume effect the change as a visual aid to tuning

take care of service problems. It is said the set comes in four colors, brown, green, cream and black. The dealer buys all four in a carton, but after he disposes of the first lot he can order any assortment he chooses. Each receiver comes in an individual carton, of course, and is designed so that the owner can ship the set back to the manufacturer if something goes wrong.

The tubes in this receiver are sealed in; no serviceman's inquisitive screw-driver can pry into it. If the set gets into trouble, the owner puts a dollar in an envelope, which is provided for the purpose, pushes the envelope into one of the ventilating slots, ships it back, and gets the set fixed at the factory.

Good opportunities which some feel are being overlooked exist in the high-class recording scheme whereby a listener can record for future entertainment his favorite programs. Such schemes offered in the past have suffered from technical ills, and the fact that the records were so small that a lengthy musical selection could not be recorded. The idea of people making their own records by speaking or singing seems to fail because so few people have anything to say. To offset the average person's inarticulate stare into the microphone a booklet might be supplied offering suggestions to the listener of bright sayings he might register for his grandchildren to chortle over. There is a precedent for this booklet in the specimen Mother's Day greetings the telegraph companies have available.

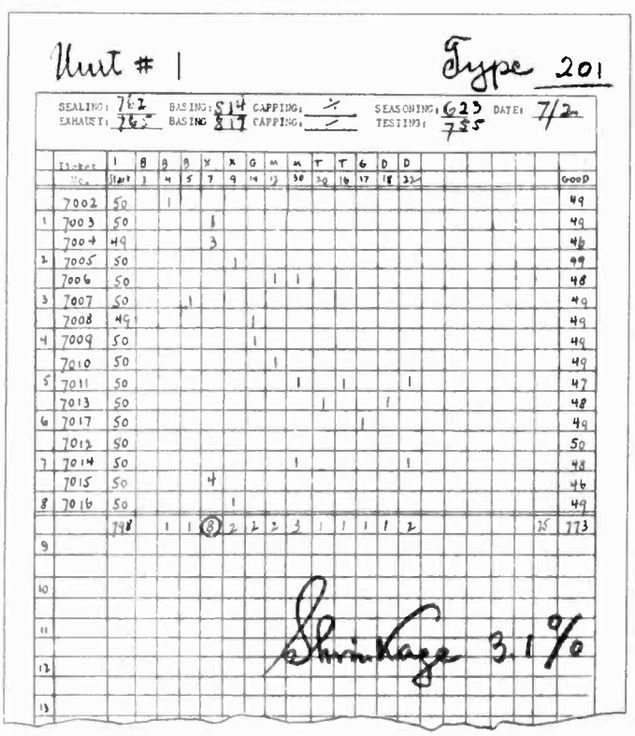
The new Radiola set (84) is reputed to be using much better recording equipment, i.e., a double-button microphone, better grooving, etc. Whether such improvements will open up a new hobby is difficult to state. A home recording proposition is reputed as nearly ready to offer the public which plans to use large, and good, record materials. The record is bought for a dollar and sent back to the manufacturer to be hardened or otherwise processed.

Shrinkage control in radio tube manufacture

By L. L. SCHREINER

IN A RECENT article in *Electronics* (July, 1932) costs in radio tube manufacture were discussed and the fact was stated that many tube manufacturers are forced to sell below costs.

The writer indicated many important problems such as correct planning, scheduling, purchasing and continuous control of costs and the sad fact that manufacturing costs are above sales prices, a fact known to many manufacturers.



Sheet showing different reasons for shrinkage

Correct and interesting as the figures of Mr. Conway are, two important items do not appear: administration and sales expenses. Here we may find surprisingly high figures or burdens per tube. Suppose the president of a large tube corporation draws a salary of $20,000.00 per year and only two million tubes were actually produced; the burden of the president's salary alone amounts to $0.01 per tube. The administration overhead expenses, the varying sales expenses, etc., are so seldom checked in time and are so difficult to budget ahead, that here alone large differences on the actual tube cost will occur.

Highly important, therefore, is the knowledge of those burdens per tube distributed over a whole year's period. Furthermore the shrinkage cost of the individual tube types is vastly important. It is not enough to establish an average percentage of shrinkage against the total production started, and then to say: the shrinkage is 5 per cent overall. *It is necessary to know the actual percentage of cost increase on every type due to shrinkage.* Mr. Conway's composite cost sheet shows the actual production of two weeks. Many overhead expenses however are to be distributed over a whole year's period and we have to bear in mind, that the actual activity in a radio tube plant has a period of only six to eight months. Sales commissions and royalties to be paid must not be overlooked; for two years small fractions of a cent have been of considerable importance in cost finding.

What has to be sacrificed is a question to be solved by highly trained industrial engineers experienced in the manufacture of radio tubes and photoelectric cells. There are but a few men available who combine the science of plant management, accounting and technical knowledge of tube manufacture. But those qualities alone would not be sufficient. Those engineers must have the courage and energy to point out to the president all the weak places in the organization or the management and must have the power to eliminate ruthlessly all the unnecessary expenses of the organization. The very existence of many tube manufacturers may depend on the courage of under engineers in pointing out to executives losses unfortunately visible to all but those who can effect needed economies.

It is a known fact that after the failure of two large tube manufacturing plants, large inventories of machinery, equipment, supplies and obsolete raw material were found, which for a year or more stood unpacked in the cellar or stockrooms. In both cases a checkup of the purchasing department would have saved many thousands of dollars to the company.

Shrinkage—a profligate spender of dollars

One of the main items in the prime cost of the radio tube is the shrinkage. It varies on certain types and under different working conditions and under varying climatic influences. Many plants will find that after holidays the shrinkage always increases. During the vacation the pumps were not working, half finished products stood too long exposed to moisture, immediately before the help was less careful, etc. The most carefully planned schedule and efficiency is offset by "a bad run."

Taking Mr. Conway's figures of an average material cost of 0.113196 and total direct labor of 0.04714 (which in one instance has been reduced to .03722) the shrinkage cost per year would vary between $9.000.00 and $10,000.00 per million tubes (material and labor only). With the added expenses of direct overhead, an amount is reached which immediately points to the possibility of savings.

Starting in the small part department it may be found that it is possible to wind grids in a more economical way. A few millimeters saved on each "moly" grid is just as important as the time required for the operator

Type: 201-A No. 7020

Operation	Date	Operator	Operator	Defects	Good
Mount Filam.	—	—	—	—	—
Mount Grid	—	—	—	—	—
Mount Ass'y	7/3	182		—	50
Inspect	7/3	110			50
Sealing In	7/3	176			50
Sealing Insp.	—	—			—
B_3 B_5 B_{10} B_{15}			S_{14} S_{19}		
Exhaust	7/3	221			50
Exhaust Insp.	7/3	114		1	49
B_1 B_5 B B_{15} B_{17}		X_1 1	S_2 S_3 S_4 S_{14}		
Basing	7/3	303	304	—	49
Basing Insp.	—	—	—		—
B_3 B_{17} B_{29}					S_{14}
Seasoning	7/4 M3 1	623		1	48
Testing	7/4	755		2	46
B B B_{15} B_{17} B_{18} B B			T_6 T_{11} 1 1		
Packing				0	46
Life Test					

Sample of tray ticket showing the shrinkage on a lot of 50 tubes

on the automatic grid-winding machine to stretch, to cut and to trim. Stem making and bending can be done with nearly no shrinkage at all when the material is right, when the fires are set correctly and when the bending dies are working properly.

Methods of checking shrinkage

Most all tube plants employ the tray ticket system. Lots of 50 or less tubes are accompanied by a special ticket on which the shrinkage reasons are marked by symbols. The cost department compiles the shrinkages reported on the tickets, analyses the percentage of each shrinkage reason and sends reports to the engineers and to the management. It has been the procedure in one plant to show also the cost figures of the shrinkage involved.

Where a large production is running and with over 40 types of tubes on schedule, planning and scheduling are often offset by urgent demands by the sales department for a special type. If it happens that the mounted tube of a certain type does not or can not reach its finishing processes the same day, exhaust machines and bombarders have to be adjusted in a hurry and immediately a high percentage of shrinkage results.

A quick-acting shrinkage control system is of utmost importance. Some plants are not able to keep a large staff of supervising engineers on the floor. Mistakes are possible and the real shrinkage often disappears (along with the tray ticket) in the ash can. Therefore it has been the practice to register every tray ticket in the office. In one plant it happened that perfectly good tubes were registered as shrinkage and in some way spirited out of the plant to appear later in obscure stores!

The installation of a foolproof system to check costs, production and stock of finished products is highly essential. The management must know every day what has been mounted, what was packed, what was shrinkage and what was shipped.

A shrinkage-control system that reduces tube costs

In one plant the following system was adopted:

1. Raw material requirements are figured out for a given monthly schedule. Work in process from the previous month is deducted. The foremen draw the necessary raw material on requisition tickets. If more shrinkage occurs, the requisition for excess material is drawn on an excess material ticket which is red in color.
2. Productive labor has been time studied and placed strictly on piecework basis, therefore giving a nearly constant cost. No time for "waiting" is paid.
3. Indirect labor was time studied and budgeted on a basic rate for each individual job and expressed in hours. Unproductive hours were cut to the minimum. Operators on furnaces or in part stockrooms were supplied with work to eliminate idle waiting time.
4. All shrinkage is reported daily from all departments. At four o'clock in the afternoon, the shrinkage sheets of the day are taken off, the shrinkage compiled

[*Please turn to page 358*]

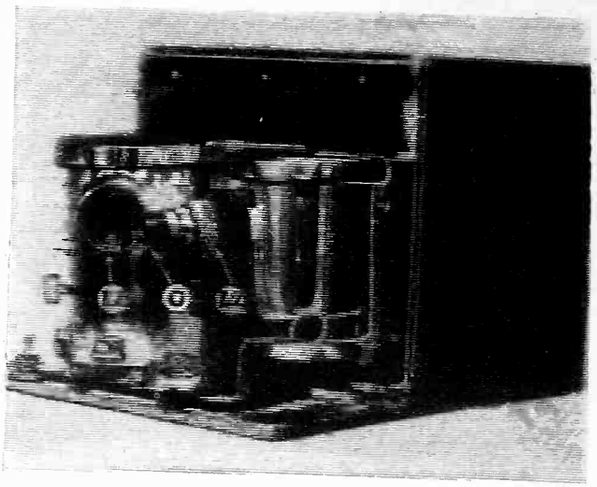
SHRINKAGE REPORT SYMBOLS.

Symbol	Shrinkage cause	Responsible Departement
F 1	Poorly shaped Flare	A-3
F 2	Cracked chipped "	"
F 3	Flare too large	"
F 4	Flare too small	"
F 5	Flare poorly cut	"
F 6		
S 1	Stem tubing cracked	"
S 2	Press cracked	"
S 3	Flare cracked	"
S 4	Flare chipped	"
S 5	No hole in stem	"
S 6	Press poorly shaped	"
S 7	Press smoked	"
S 8	Leak at press	"
S 9	Press too thin	"
S10		
S11	Open circuit	"
S12	Lead wires too close	"
S13	Lead broken or burned	"
S14	Exhaust tube broken in	"
S15	Defective raw material	"
S16	Stem smushed in Dptm.	"
S17	Glass broken at MS.	"
S16	Crooked exhaust tube	"
S19		
S20		
B 1	Cracked seal	A-5
B 2	Hole in Seal	"
B 3	Poor shaped seal	"
B 4	Cracked bulb	"
B 5	Cracked Top	"
R 6	Broken Bulb Raw material	
B 7	Hole in Top	"
B 8	Mount not centered	"
B 9	Over all length bad	"
B10	Top wire broken	"
B11		
B12		
B13	Bumped mount	"
B14	Top seal too long	"
B16	Leaker	
B16	Sucked in Bulb	"
G17	Burned out	"
B18		
B19	Punctured Bulb	"
B20 M20	Cold heater	
B21	Long Tip	
D18	No contact in solder	A-7
D22	Blistered Base	A-7
D23	Loose Base	"
D24	Crooked Base	"
D25 R25	Defective Base	"
D26	Loose Cap	"
D27	Poor soldor	"
D28	Short circuit in base	"
D29		
D30		
X 7	Gassy tubo	A-6
X 9	Low emission	A-6
X15	Cathode melted	A-6
X18	Airy lamp	A-6
X27	Coating tipping off	A-6
X28	Cathode not broken	A-6
G13	Split plate	"
G14	Exhaust tube broken	A-5
G17	Burned out in	A-6
P 1	Plate not correct sized	A-1
P 2	Grid not correct turns	A-2
P 3	Cage poorly welded	A-3
P 4	Plate current too low	A-4
P 5		
P 6		
P 7	No Mercury in sleeve	A-1
P 8		
P 9		
P10		
P11	No getter in cup	A-1
H 1	Filament current too high	A-2
H 2	Filament current too low	A-2
H 3	Tabs poorly welded to Fil.	A-2
H 4	Poorly clamped spoons	A-2
H 5	Poor coating of Filament	A-2
H 6	Filament coating weight bad	A-2
H 7	Heater Cathode short	A-2
H 6	Heater Cathode Leakage	A-2
H 9		
H10		
M 1		
M 2		
M 3	Plate current too high	A-4
M 4	No getter in Mount	A-4
M 5	No Mercury sleeve in Mount	A-4
M 6		A-4
M 7		A-4
M12	No reading	A-4
M13		A-4
M14	Loose filament	A-5
M20	Cold heater	A-4
M17	Cathode Tube not welded	A-4
M29	Short in Mount	A-4
M30	Poor weld in mount	A-4
M33	No getter in cup	A-4
T 1		
T 2		
T 3		
T 4		
T 5		
T 6	Plate Variation on 80 Type	
T 7		
T 8	Cold leaker	
T 9		
T10	Voltage drop too great	
T11		
T12		
T13		
T14		
T15	Noisy	
T16	No emission	
T20	Poor appearance	
T23	Missing Tube	
T29	High screen current	
K19	Poor brand	A-8
K22	Wrong brand	A-8
J21	Tube jarred or smashed	Dptm.
N 1	Not our make (for returns)	
O 2	Old construction "	
V 3	Cap off on returned tube	

Sample of a shrinkage sheet with shrinkage compiled

Photoelectric control in the printing arts

Note: The front cover illustration of this issue, showing the Howey photoelectric engraver, was engraved on the machine pictured



Scanning head of photoelectric engraving machine. L,L are lamps which intensely illuminate spot on the photograph passing in front of the optical system O containing the photocell

THE many remarkable uses which the photoelectric cell is finding in the printing and engraving arts and associated industries, were illustrated and demonstrated Oct. 19, at New York City, by a group of speakers representing prominent electrical laboratories and publishing organizations. The meeting was under the auspices of the Science Forum of the New York Electrical Society, a number of important printing and publishing executives and electrical men being present.

Half-tone engravings were made in a few minutes' time, without acids, in less time than it took to write the corresponding captions, and for the first time a new three-color engraving process was demonstrated, by which complete three-color plates can be produced within half an hour instead of the 36 hours heretofore required, and at a fraction of the cost of the ordinary three-color process.

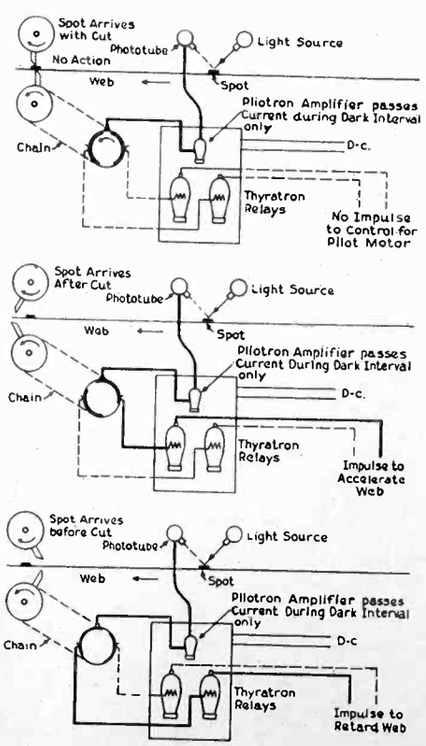
During the symposium, in which six speakers took part, sixteen applications of photoelectric phenomena to the printing arts, were covered, as listed on this page.

Rapid production of half-tones and three-color plates

Walter Howey, director of International News Photos, demonstrated for the first time in public his new photoelectric process of engraving three-color half-tone plates, and exhibited copies of newspapers illustrated throughout with half-tones made by photoelectric scanning, at a great saving in cost and in time of preparing cuts. "In fact," said Mr. Howey, "the cuts were actually made in less time than it took the copy-reader to write the corresponding captions, or the compositor to set the lines."

In Mr. Howey's process, the photograph to be reproduced is mounted on a revolving cylinder which is scanned by a phototube at a rate of about 10 square inches per minute. The photoelectric currents are amplified up to a third of a horsepower to operate an engraving tool which cuts into a metal plate, lines of light and dark, corresponding to the light and dark elements of the picture. By reversing a switch, explained Mr. Howey, negatives can be directly obtained, or intaglio cuts made directly for off-set work. For newspaper work, eighty lines per inch has been adopted. Half-tones made during a month's operation of the *Syracuse Journal* averaged a cost of three-quarters cent per square inch. The front cover of this issue of *Electronics* shows Mr. Howey's engraving machine printed from a half-tone plate made by the machine itself.

The three-color process shown makes its own color separation, the phototube at each scanning separating out the particular color desired. Three-color plates can be turned out in two hours, that would otherwise take two days. Mr. Howey also exhibited his liquid color-filter for removing infra-red and heat from the rays of a 1,000-watt airplane beacon used for enlarging and printing, with a speed 200 times that heretofore employed.



Photocell used to control register of cut-off knife by printed forms. Installation by General Electric Company in plant of Jaite (Ohio) Paper Company

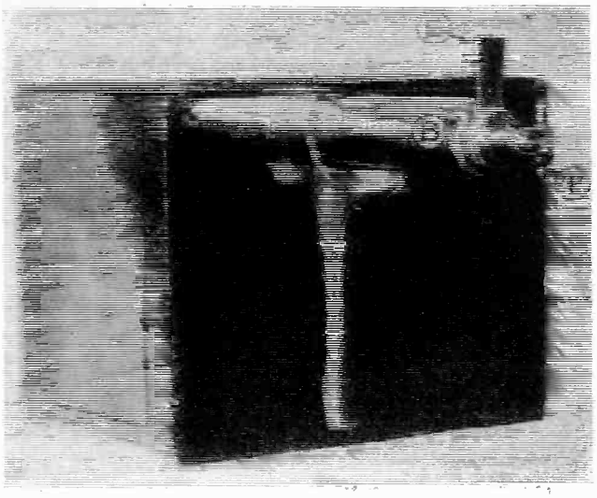
John B. Bassett, district engineer for the General Electric Company at New York, described some of the many applications of the photocell for mechanical control in printing and paper-making plants, developed by the Schenectady laboratories of his company.

One of the most interesting of these is the automatic press-stop which "sees" an impending break in the roll of paper being fed to a press and instantly operates to stop the machinery, minimizing the loss and press-room disorder resulting from such a break. Another is the "flying paster" which makes it possible to put on a new roll of paper when the roll ahead runs out, without stopping the press. Other photoelectric applications include the automatic setting of type from code characters on the reporter's typewritten copy, inserted by a special typewriter face; safety stops and safety devices on feed-rolls; bindery and shipping-room door openers; illumination control, etc.

Anthony Lamb demonstrated the new Weston Photronic cell as applied to various uses of interest to printers and publishers, and exhibited illustrations of the cell in use for detecting print showing through newspaper, counting magazines and forms, measuring illumination and maintaining necessary intensities in press-rooms, engraving plants; preventing paper-breaks, etc. "From the paper, pulp and printing industries many requests have come for the solution by photocells of various problems," said Mr. Lamb. "Analyzed, these inquiries were made up 30 per cent for devices to measure paper opacity, 20 per cent for illumination measurements, 16 per cent for alarms to prevent paper breaks, 15 per cent for cutting paper on a printed mark, 14 per cent for the counting of objects, such as sheets, cartons, logs, etc., and 5 per cent for measuring color."

Matching colors, measuring opacity, glare

A device new to the printing industry, the colorscope, was shown by its inventor, Prof. H. H. Sheldon of New York University. This instrument matches colors electrically. The colors to be compared are placed before two photoelectric cells which form two branches of a balanced circuit. Intensity differences of the samples to be matched are then registered at once on an electric meter. The color differences are later determined by use of primary color filters. A calibrated iris diaphragm allows the differences to be expressed in per cent of total light whether the samples be white, black or any color or shade. The device is wholly independent of any judgment on the part of the operator and is about as simple to operate as the modern radio.



Cutting head of photoelectric engraver, driven from scanning head shown opposite. T is cutting tool carried on thrust-bearing B, and adjustable by eccentric E. These engravings, as well as the front cover illustration of this issue, were made on the machine itself

Elmore B. Lyford, engineer for the American Photoelectric Corporation, New York, exhibited a photoelectric colorimeter for liquids, and a reflection meter for opaque materials. These instruments are used for the purpose of comparing and measuring color differences between similar colored materials. They have a sensitivity as much as forty times that of the human eye in detecting color differences, and the speaker showed how they are used for matching inks, papers and dyes. The colorimeter is also used for determining turbidities, sulphate measurements, etc., while the reflection meter gives a rapid method for obtaining paper reflection, glare and opacity.

SIXTEEN APPLICATIONS OF PHOTOCELLS TO PRINTING, PUBLISHING, ETC.

1. **Automatic machine setting of type, from reporters' typewritten "copy."**
2. **Half-tones made by photoelectric scanning, without acids, and in a fraction of the time usually required (both one-color and three-color plates).**
3. **Automatic control of accurate register on web presses, for subsequent color runs.**
4. **Automatic control of accurate trimming, and accurate cut-offs for labels, bags, etc.**
5. **Automatic stops for presses, preventing expensive paper-breaks.**
6. **Counting of sheets and forms in binderies; counting of logs in paper mills.**
7. **Control of thickness and moisture of paper stock during manufacture.**
8. **Matching the colors of inks and papers; providing permanent color records reproducible at any time and proof against fading or change.**
9. **Measuring glare and opacity of paper.**
10. **Transmitting photographs by wire and by radio.**
11. **Safety-first devices around presses, on feed rolls, etc.**
12. **Detecting and correcting press-vibrations.**
13. **Automatic door-openers for binderies and shipping rooms.**
14. **Circulation analyzers and office conveniences.**
15. **Automatic mailing sorters.**
16. **Adjusting correct illumination intensity in composing rooms, press rooms, engraving plants, etc.**

The ribbon microphone and its applications

By JULIUS WEINBERGER

Research Section, Engineering Dept., RCA Victor Company, Inc.

FOR a number of years relatively little progress has been made in the most essential element used in the translation of sound to electrical energy, namely, the device usually referred to as a "microphone." The advent of broadcasting and sound motion-picture recording produced an increased interest in the development of microphones having a high degree of fidelity, resulting in the introduction of the condenser transmitter. For fifteen years this was considered the standard type of high-fidelity microphone. Now a new device called the "ribbon microphone" has made its appearance, which possesses interesting advantages over the condenser microphone and which promises to open up new fields of usefulness in the application of sound pickup devices.

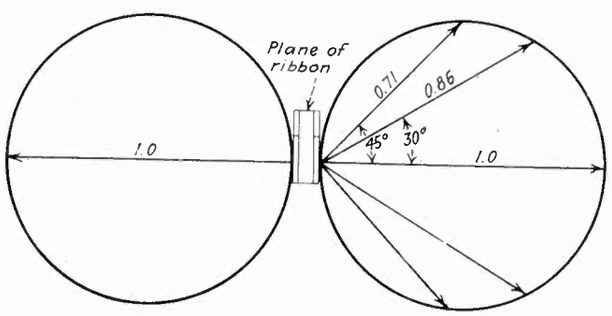


Fig. 1—Directional characteristics of ribbon microphone

Principles of operation

The ribbon microphone has been chiefly developed by Dr. Harry F. Olson of the RCA Victor Company, and originated, as did the condenser microphone, in an attempt to devise an instrument for certain sound measurement purposes. A sound wave in air is characterized by two components. One is the pressure at a given point in space, and the other the velocity of the air particles at that point. These two components are analogous to the voltage and current at a point on a transmission line along which an electric wave is progressing. The condenser microphone measures the pressure at a given point in air and corresponds to a voltmeter. The ribbon microphone was devised in order to measure the velocity of the air particles and is analogous to an ammeter. There is an additional important difference in the functioning of the two devices. Pressure is non-directional, that is, a sound pressure measuring device would theoretically show the same pressure at a given point regardless of the direction in which it was turned. Velocity, however, is a directional effect; the air particles move with maximum velocity along the direction in which the wave is progressing and have zero velocity at right angles to that direction. A velocity measuring device such as the ribbon microphone would therefore indicate a maximum when turned so that it faced in the direction of maximum velocity and zero when placed at right angles to this direction. Hence, the ribbon microphone is an indicator of the direction along which the sound wave is progressing. Being a directional device, it can be used to receive sounds coming from certain directions, or to have zero reception for sounds coming in a certain plane, and its directional characteristic is practically the same at all frequencies. It is the first sound collection device to possess these unique properties.

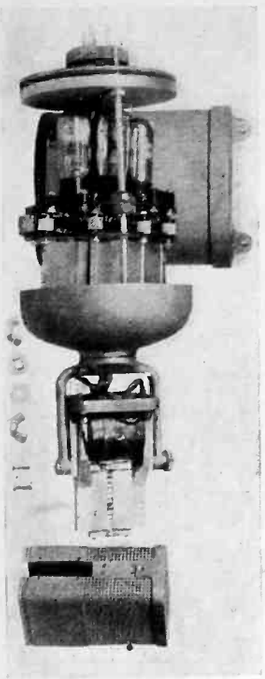
The theory of the motion of such a ribbon under the influence of a sound field[1] showed that if the ribbon had certain dimensions, if both sides were open to the wave, and if there were as small a path as possible between the back and front of the ribbon (i.e., short distance around the magnet structure or perforated magnet pole), then the device would possess a directional characteristic at practically all frequencies, of the character shown in Fig. 1. It would thus be a *velocity-responsive* device, in contrast to most microphones, which are pressure responsive devices. The latter is the case when, as is usual, only one side of the moving element of the microphone is exposed to the sound wave, the back being closed off.

Figure 2 shows the principle of construction of the ribbon microphone, and the method of connecting it to an amplifier, as used in one of the models made by the RCA Victor Company. The microphone consists of a very light piece of aluminum foil, corrugated and suspended between the poles of an electromagnet. Its natural frequency is below the audible limit. The terminals of the aluminum ribbon are connected to a step-up transformer, the secondary of which feeds a resistance-coupled amplifier. When sound waves act upon the ribbon, it moves in accordance with the character of the waves, and the currents induced in it are then amplified to the required degree.

It will be observed from Fig. 1 that sounds striking the ribbon from a direction parallel to its plane are not responded to at all, while sounds from a direction perpendicular to its plane produce maximum response. Between the two extremes, a cosine distribution response exists. Theory and experiment also indicate that the frequency characteristic is practically uniform, that is, the voltage generated by the ribbon is independent of frequency. However, for sound motion-picture recording it is desirable to increase somewhat the voltage supplied from the microphone at the higher frequencies, and for this reason a choke coil is placed in series with one of the resistances in the amplifier shown in Fig. 4, so as to produce a slightly rising amplification towards higher frequencies.

The voltage generated by the ribbon microphone is

[1] For the complete theory, see H. F. Olson, *Journal of the Acoustical Society of America*, Vol. III, pp. 56-68, 1931.



Left—Fig. 2—Ribbon microphone with amplifier

Right—Fig. 3—Sound motion picture type of ribbon microphone with amplifier

of approximately the same order of magnitude as that of the dynamic microphone, when supplied to the grid of a tube through a suitable transformer. It is about twice the voltage which a condenser microphone will deliver under similar conditions.

Examples of construction

Figure 3 illustrates the type of construction employed in a ribbon microphone and associated amplifier, for sound motion-picture recording. The microphone is enclosed in a perforated case, mounted on swivels, below the amplifier. The latter is housed in a completely closed aluminum case, at the top of which is a jack into which an overhead cable may be plugged. This type of construction is designed for overhead suspension, which is the usual practice in sound picture pickup. The ribbon and magnet structure can be seen clearly with the microphone field coil mounted directly above the ribbon.

It is not essential to associate the microphone and amplifier as closely as shown in this type of construction. The microphone transformer may be designed to feed into a transmission line and several hundred feet of properly shielded twisted pair may be used between the microphone and amplifier, if this should be desirable for any reason. At the amplifier end of the line a second transformer may be used to step up from the line to the grid of the first amplifier tube. This type of connection is employed when the microphone is used in radio broadcasting studios.

For broadcasting studio use the microphone and its transformer are mounted on a suitable stand, and the microphone amplifier is located on a panel in the adjacent control room.

Applications of directional effects

The directional sound pickup properties of the ribbon microphone permit its utilization for a variety of new purposes. The chief of these may be classified as follows:

(a) Elimination of undesired interfering noises.
(b) Reduction of recorded reverberation.
(c) Bilateral sound pickup (i.e., equal sound pickup from sources placed on opposite sides of the microphone).
(d) Extent of sound pickup regulated by placement of angle of source of sound with respect to microphone, as well as by distance of source from microphone.
(e) Elimination of acoustic feedback in public address systems, or from monitoring loudspeakers, by suitable angular positioning of microphones with respect to loudspeakers.
(f) Elimination of reflection difficulties in acoustical measurements.
(g) Determination of direction of a source of sound.

In sound motion-picture work, the microphone is hung overhead and tilted as shown in Fig. 5. Under these conditions a large part of the camera noise may be eliminated, while the speech of an actor is picked up. Heretofore bulky and clumsy sound-proof hoods have been used over cameras to diminish interference from this source, but with the increasing use of the ribbon microphone these are becoming obsolete.

Reduction of the reverberation present in the recorded sound is inherent in the directional character of the ribbon microphone. Since its zones of reception are restricted to only certain directions, it will not respond to reflected sounds arriving from directions other than these. If reverberation is considered as sound incident from random angles, then it has been shown theoretically that the energy response of the ribbon microphone to such sounds is only one-third that of a non-directional

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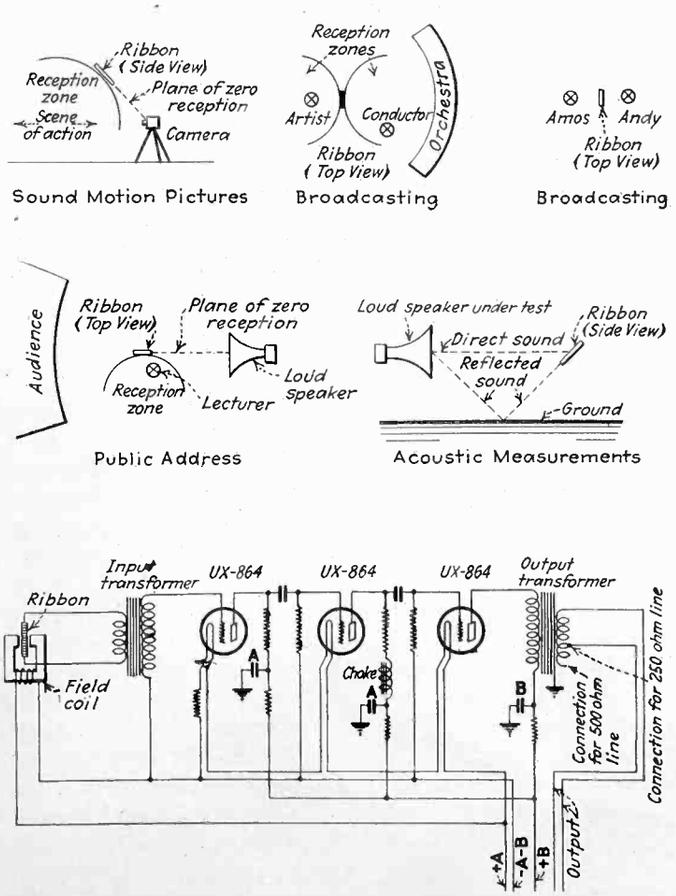


Fig. 5—Various applications of the velocity of ribbon microphone

A study of high-frequency heating

By K. C. DEWALT

General Electric Company, Schenectady, N. Y.

EVER since a famous Viennese doctor and scientist first proposed that fever was nature's combatant of disease many experiments have been made to develop methods for the production of artificial fever. This work has been directed mainly towards the use of mild forms of typhoid and malarial fevers. It is only recently that electric fields have been utilized to produce the current necessary to heat the body.

The present apparatus for the production of fever is a development of a small induction type of heater which Dr. W. R. Whitney once used in an attempt to grow artificial galls on plant stems. Later an electromagnetic field at very high frequencies was used and the effects produced in rats and mice were studied.

Shortly after these early experiments, Dr. Whitney observed an elevation in the body temperature of men working in the field of high-power, short-wave, oscillators. Since then, considerable experimental work has been done to adapt this energy to the production of artificial fever.

Theoretical development

Considering the problem from a purely electrical standpoint an equivalent circuit can be built up and analyzed. In Fig. 1, a typical arrangement for the heating of a rectangular parallelopiped is shown. Figure 2 represents this in an equivalent network. In dealing with this problem, the material to be heated is considered to have the characteristics of a pure conductance which does not change appreciably over the range of frequency to be covered.

The metal electrodes are connected to a source of high-frequency voltage. $E_m \sin \omega t$. The field at the electrodes will be considered uniform and the electrical power supply of ample capacity to maintain a constant voltage when other conditions are varied. Similar equations can be developed considering a constant current supply, but this condition is not common in practice. Capacitances, C_2, in series with the sample may be consolidated into one capacitance, C, which is equal to $C_2/2$. The parallel capacitance, C_1, is important only when the conductance, g, of the sample is very low. The capacitance, C_3, in parallel with the network, does not enter in the calculations if the voltage, E, (r.m.s.) is kept at a fixed value. Of course, this capacitance would enter in considering the total current I_o, and the power factor of the whole network but, since these factors concern only the generating equipment, they will not be considered at present.

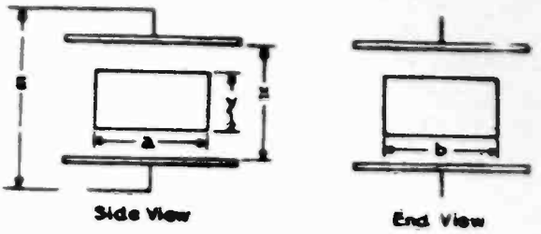


Fig. 1—Object, parallelopiped in form, between condenser plates

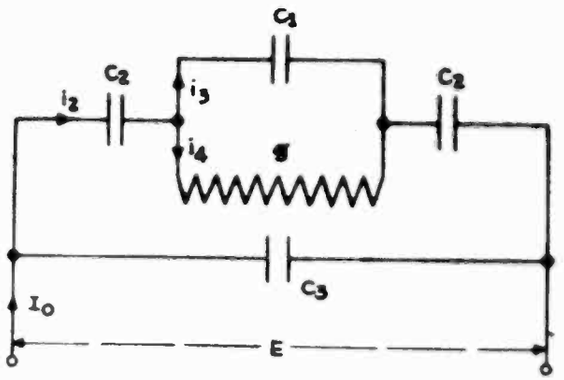


Fig. 2—Equivalent circuit of heating plates and object

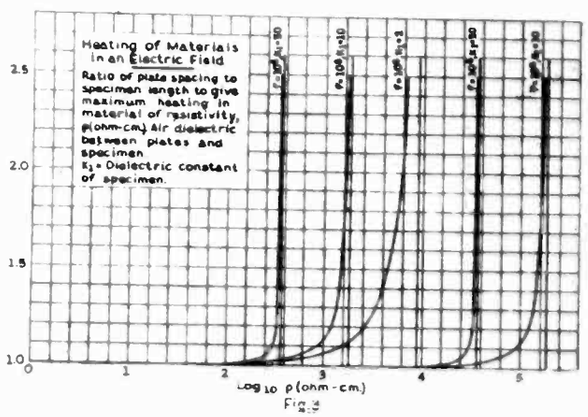


Fig. 3—Effect of dielectric constant and frequency on heating

In developing the value of power loss in the conductance g, the following equations may be set up:

$$E = i_2\left(\frac{1}{jwC_2} + \frac{1}{g + jwC_1} + \frac{1}{jwC_2}\right) = i_2\left(\frac{1}{jwC} + \frac{1}{g + jwC_1}\right) \quad (1)$$

$$i_4 = i_3\frac{g}{jwC_1} = E\frac{jwgC}{g + jw(C + C_1)} \quad (2)$$

solving this expression the current becomes

$$I_4 = E\frac{\omega gC}{[\omega^2(C + C_1)^2 + g^2]^{\frac{1}{2}}} \quad (3)$$

and the power loss is given by

$$W = E^2\frac{g}{\left(\frac{C+C_1}{C}\right)^2 + \left(\frac{g}{\omega C}\right)^2} \quad (4)$$

Considering this equation, it would appear that a maximum power loss will occur as the conductance is varied. By differentiating the above expression with respect to g and equating to zero, this condition for maximum loss is found to be

$$g = \omega (C + C_1) \tag{5}$$

Substituting this value in equation (4) the maximum loss is shown to vary with the frequency as

$$W \max = \pi E^2 \left(\frac{C^2}{C + C_1}\right) f \tag{6}$$

In analyzing the condition as given in (6), it is found that for given values, a certain ratio of electrode spacing to specimen length must be maintained. This condition is obtained by substituting the equations for conductance and capacitance in (5). Referring to Fig. 1 for the dimensions, and designating the dielectric constant of the specimen by K_1, and the resistivity by ρ, the condition for air dielectric between the electrodes and the specimen becomes,

$$\frac{x}{y} = 1 + \frac{1}{\dfrac{1.8 \times 10^{12}}{\rho f} - K_1} \tag{7}$$

which shows that for a definite ratio of x/y, the frequency must be varied inversely as the resistivity. This ratio of electrode spacing to specimen length is plotted in Fig. 3 which shows also the effect of dielectric constant and frequency on the shape and displacement of the curves. The vertical lines are the critical values of ρ at which $g = \omega C_1$. Several frequency-resistivity characteristics for maximum heating are shown in Fig. 4.

Applications to practical conditions

Having developed these general equations it is interesting to consider some special conditions met often in practical applications. If the assumption is made that the resistance of the specimen is much less than the capacitive reactance, the above equations may be simplified to show some interesting conclusions. As a first assumption then, let $g >> \omega C_1$, and (4) becomes

$$W = E^2 \frac{g}{1 + \dfrac{g^2}{\omega^2 C^2}} \tag{8}$$

Equation (5) becomes $g = \omega c$, and (6) as

$$W \max = \pi E^2 C f \tag{9}$$

These equations hold for any frequency and conductance that satisfy the limitation, $g >> \omega C_1$.

In further considering practical cases, it is found that the frequency for maximum power loss is much too high to obtain easily. A simple calculation will show this fact. If the electrodes are not in contact with the sample and the ratio of x/y is 1.2, the following values of frequency are obtained for various values of resistivity: (K=10)

ρ ohms cm^{-3}	f Cycles sec	λ (wavelength) c.m.
10^2	1.2×10^9	25.
10^3	1.2×10^8	250.
10^4	1.2×10^7	2500.

These data indicate that, except for the very high values of resistivity, the conditions are such that the point for maximum heating is difficult to obtain. With this limitation in mind, the above expressions can be simplified further. Thus (8) becomes

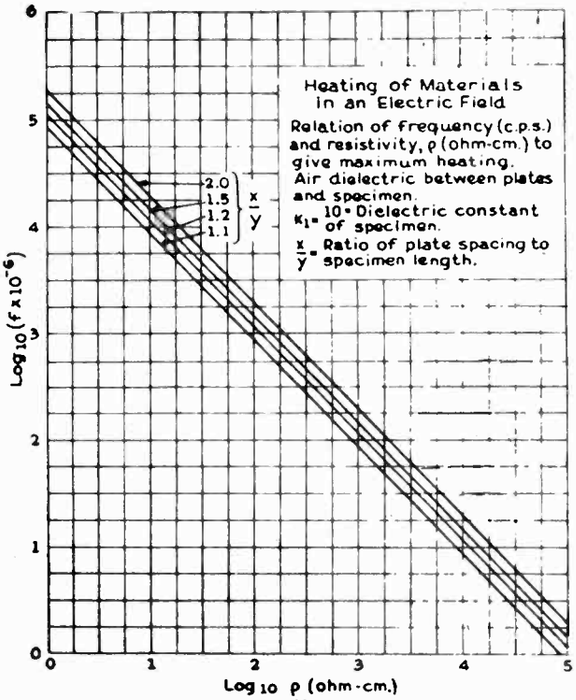


Fig. 4—Frequency-resistivity characteristics for maximum heating

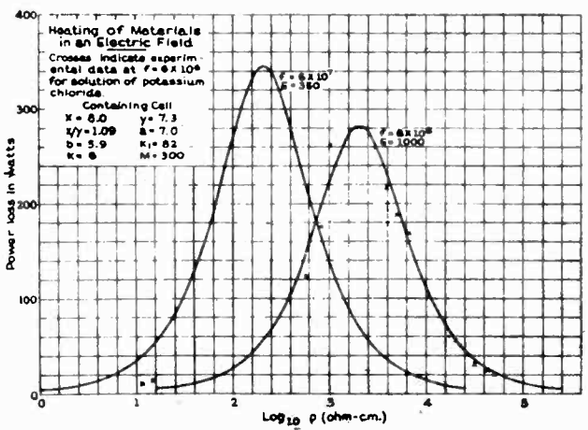


Fig. 5—Power loss curve of potassium chloride as a function of resistivity

$$W = \frac{E^2 \omega^2 C^2}{g} \tag{10}$$

Also, this loss may be determined from the rate of temperature increase, $\frac{d}{dt} T$, the mass, M in grams, and the specific heat, s, of the specimen and thus may be represented by

$$W = s M \frac{d}{dt} T \tag{11}$$

These may be equated to obtain an expression for the rate of heating as

$$\frac{dT}{dt} = \frac{E^2 \omega^2 C^2}{s M g} \tag{12}$$

For any rectangular parallelopiped element, the conditions are

$$g = \frac{A}{\rho y}; \quad c = \frac{K A}{d}; M = \sigma V = \sigma A y$$

and, when

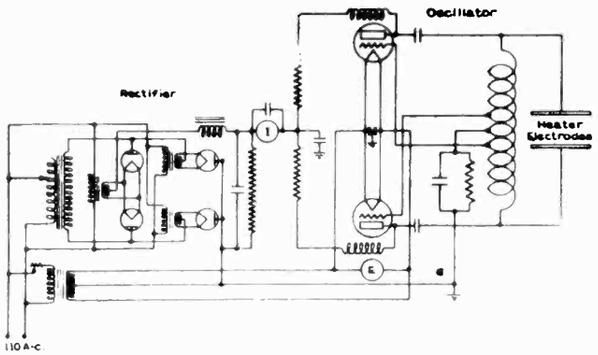


Fig. 6—General circuit diagram of power supply and oscillators

these substitutions are made the rate of heating becomes

$$\frac{dT}{dt} = \frac{E^2\omega^2K^2\rho}{s\sigma d^2} \qquad (13)$$

which shows that regardless of shape or size, the rate of heating is the same.

If, in (13), d is a distance determined by the working voltage of the dielectric between the body and one electrode, the rate of heating for one set of conditions reduces to simply,

$$\frac{dT}{dt} = \text{a constant} \times f^2 \qquad (14)$$

There is another aspect which must be considered in all applications and that is the efficiency versus frequency characteristic of the generator. The equations developed show that the power loss varies as the frequency squared and, therefore, the higher the frequency the greater the heating. However, the characteristics of vacuum tubes and their associated circuits are such as to produce a rapidly decreasing efficiency characteristic as the frequency approaches a limit at which the output is zero. There will then be a point where the maximum heating will be produced and, if the efficiency vs. frequency characteristic is known, this point may be calculated readily. For illustration, assume that the useful efficiency of the apparatus may be represented by

$$\eta = \eta_0\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right] \qquad (15)$$

wherein η_0 is the maximum efficiency and $\omega_0/2\pi$ is the limiting frequency at which the efficiency is zero. Using the simplified equation (10), the optimum frequency is shown to be

$$f = \frac{\omega_0}{2\pi}\left(\frac{1}{\frac{E^2C^2\omega_0^2}{\eta_0 g P} + 1}\right)^{\frac{1}{2}} \qquad (16)$$

where P is the total power input to the apparatus.

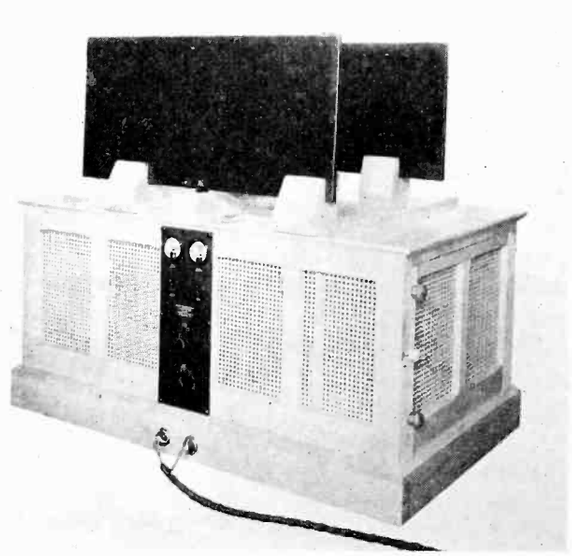


Fig. 7—Therapeutic unit, 1-kilowatt in power

Experimental results

No attempt is made to show complete correlation with the theory but several curves are plotted to illustrate, for a typical example, the nature of the effect produced.

The power loss curve for a solution of potassium chloride is plotted as a function of resistivity in Fig. 5. The theoretical curves as calculated from equation (4) are shown in full lines and the experimental data for $f=6 \times 10^6$, are indicated by crosses. Because of complications introduced by heating of the containing vessel and its radiation and heat capacity the agreement is not perfect. The specific heat and dielectric constant of the various concentrations do not vary appreciably from that of water and are, therefore, held constant for these calculations. The resistivity measurements were made at a frequency of 60 cycles to avoid polarization and, since the values were all relatively large, they were taken to be nearly independent of frequency within the range considered.

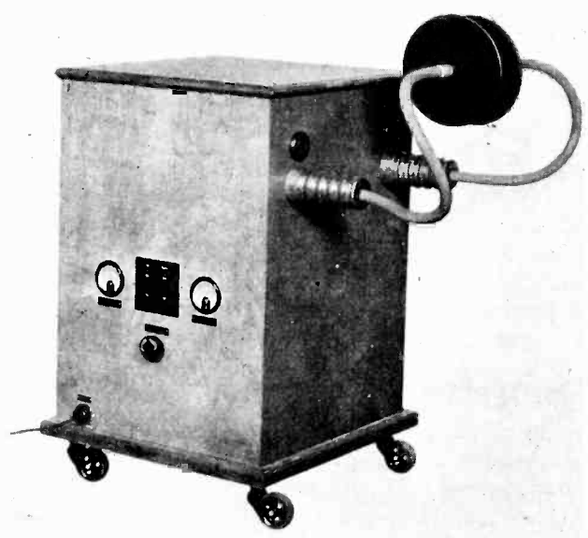


Fig. 8—Local-treatment heater, 200 watts in power

The containing vessel used for the tests was a glass jar weighing 450 grams and having dimensions, x=8, y=7.3, a=7 and b=5.9 centimeters. All the tests were made with 300 grams of solution and the time of each run adjusted to allow a temperature rise of about ten degrees centigrade. In this manner the heat lost to the containing vessel and to the surrounding air was kept fairly constant for each run. In calculating the power loss in the solution from the rate of temperature rise, the vessel was considered to absorb an amount of heat equal to its heat capacity and no allowance made for heating of the vessel itself or for radiation. If it had been possible to estimate these effects with accuracy, closer agreement between calculated and observed data might have been obtained.

[*Please turn to page 345*]

BOOKS ON ELECTRONIC SUBJECTS

Handbuch der bildtelegrapie und des fernsehens

By Dr. Fritz Schröter. Published by Julius Springer, Berlin. 365 illustrations, 487 pages. Price, 58 Reich marks. Published, July, 1932.

THE APPEARANCE of this book under the editorship of Dr. Schröter, who has distinguished himself as a director of research for the Telefunken Company and by practical contributions in his own name to the art of picture transmission should elicit the thanks of all workers in the field. The contributors, nine well-known specialists, have undertaken to bring together material covering the fundamentals, development, and the limitations of electrical picture transmission both by wire and by radio which would be useful for the engineer, the technician, and the physicist. Their efforts have resulted in an excellent consideration of all aspects of the subject. The development of the art is covered by a critical survey of the many methods which have been employed for the splitting up of a picture or a pattern for the purposes of conversion into a sequence of signals suitable for transmission, and, of course, the reverse process which involves similar but not always identical difficulties. And, as Dr. Karolus says in a foreword, although the likelihood of a new principle or invention radically different from the present firmly established process of point-by-point transmission and reception being brought forward seems rather remote there remains a great deal of careful research and refinement to be done. Whether one contemplates this type of painstaking and essential labor which holds little promise of great fame or is planning to strike out in new directions, the history of failure and development and the results of practice must be known. The virtues and the limitations of mechanical, electrical, optical, and chemical processes used in various methods are thoroughly discussed by the specialist contributors. However, foregoing a detailed review of each section (of which there are twelve, including an appendix) it can be said that all of the major problems facing the researcher or the technician in the field of telephotography and television have received careful consideration. Mechanical constructions and details of adjustment are given; cathode-ray tubes and technique are gone into. An entire section is devoted to the photoelectric cell, its theory and use. Detailed information of mirror and lens systems and the discussion of light and light sources brings together much valuable material. Methods of obtaining synchrony, circuit problems and characteristics, and the ever present difficulty of channels is covered in theory and in practical application.

This work, together with a number of other recent books on related subjects from the press of Julius Springer can not be excluded from the reference shelf of anyone seriously interested in television or in particular phases of telephotography or facsimilie transmission because of the burden of translation—a serious problem for so many. Especially for those workers who are contributing to the elimination of distance barriers it seems ironical to be faced with a language barrier which for many is as isolating a wall as distance was five hundred years ago. But until an universal scientific language is achieved we will have to juggle language as we do mathematics.

The illustrations are excellent and copious. Continuous reference to the literature is made which allows the reader to pursue ramifications of a subject as far as interest or necessity may dictate. The index could have been elaborated to advantage.

✦

Thermionic vacuum tubes and their applications

By E. V. Appleton, M.A., D.Sc., F.R.S. E. P. Dutton and company (Methuen and Co., London). 117 pages, 68 figures. Price, $1.25 (In England 3s.)

WHILE IT IS IMPOSSIBLE in a book so small as this to do justice to such a wide subject, it is an excellent treatise on the vacuum tube. The essentials of the mathematical treatment of oscillation, detection, amplification and other fundamental tube circuit characteristics are given, there is considerable history in the volume, and many applications outside communication are noted. Professor Appleton is known as a physicist rather than an engineer and his interest in the tube and associated circuit is that of a scientist. Therefore the radio engineer or industrial technician interested in a short book on the vacuum tube can be certain that the principles he finds exposed will be exactly and succinctly stated.

The size of the book is fortunate, it fits the pocket. It is one of a series of monographs on physical subjects featured by Messrs. Methuen of London. The others in the series include Wave Mechanics, X-Rays, Photochemistry, and others, twelve in all and five in preparation.

Below ten meters

The manual of ultra-short wave radio

By James Millen and Robert S. Kruse, The National Company. 64 pages. Price 50 cents.

AN EXCELLENTLY PRINTED BOOK dealing with the vast region, almost unexplored, existing in the ether below ten meters. Many circuits and photographs of foreign and American apparatus give the experimenter or anyone interested in this region a good idea of the technical problems involved in transmitting and receiving. Chapters deal with methods of generating, radiating and receiving these waves. Barkhausen-Kurz oscillators naturally come in for considerable description, but there are others which are handled as well.

Even the medical applications are outlined, the authors obligingly mentioning the fact that the average person is a half-wave resonator at about 3½ meters and that when standing near an oscillator of this wave length sufficient current will be generated in the abdominal region to light wave meter lamps and sufficient voltage at the extremities to light neon lamps. The authors encourage the experimenter to cease experimenting at this point.

There is a vast amount of interesting material in this book. Television gets its share of attention and the Empire State emissions are not neglected.

✦

The outlook for television

By Orrin E. Dunlap, Jr., Radio Editor, New York Times. Published by Harper & Bros., 15 E. 26th St., New York City. Price $4.

THIS BOOK SETS FORTH recent developments in television science and considers its commercial and other possibilities. It supplies the first historic and scientifically accurate record of the evolution of television, with an encyclopedic chronological table of all the important steps and contributions of numerous inventors toward the perfecting of this mechanism.

The book includes the estimates of prominent contributors as to the possible uses of television, including Bruce Barton on advertising, Rear Admiral Richard E. Byrd on exploration, Dr. George B. Cutten on education, Dr. Lee De Forest on home and the theater, Bishop James E. Freeman on religion, Major-General James G. Harbord on war, Colonel Theodore Roesevelt on politics, S. L. Rothafel (Roxy) on stage and screen.

HIGH LIGHTS ON ELECTRONIC

Matching colors of samples at three points

By E. D. Wilson*, C. C. Hein and R. C. Hitchcock

The portable color-matcher pictured is essentially a device for matching the colors of plates, fabrics, dyed materials, and paint samples. Minor changes allow the testing of semi-fluids, pastes, powders, and such special items as coffee, and corn flakes. Either light or dark samples can be tested, the sensitivity of the outfit allowing the matching of even very dull black surfaces. On the other hand, very bright reflecting surfaces are within the range of the instrument.

A rectifier tube, and filter circuit, provide plate and grid voltages for the matching circuit. The matching circuit comprises a low grid-current amplifier tube, phototube, coupling circuit, and sensitivity control. This control is adjusted until "zero" is obtained with the standard, then the test sample is introduced. The direction of the meter needle from zero indicates whether the tested sample is "lighter" or "darker" than the sample used as a standard.

The improvement of this optical system over visual inspection is several fold. It is independent of daylight or artificial light.

A standard concentrated-filament lamp is run at low voltage to insure long life. A tri-color filter permits transmission of one of three color bands; blue, green, or red. These three represent the short, medium and long wavelengths in the visual spectrum. A lens and mirror bring the light rays through a diffusing transmitting medium to the sample, and a white integrating cylinder brings the rays to the phototube, which has a special color characteristic to give best operation with the lamp source.

The use of three filters gives a surprisingly good match for a wide range of colors. This will be evident from a consideration of the electrical arrangement which balances the light reflected on each of the blue, green, and red, no matter what the predominating color of the test pieces may be.

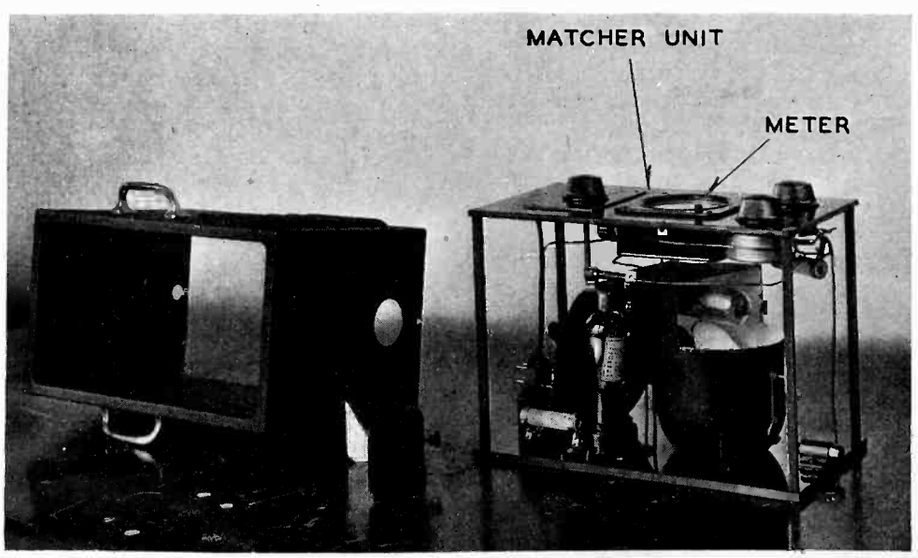
Comparing two red samples

For example, consider two red samples, in each of which 99 per cent of the diffused reflected light is red. This means that in red light the samples will appear exactly alike. When testing these samples with the color matcher red screen, the sensitivity control is turned down, so that zero is obtained on each sample with the 99 per cent red reflected light. Next, a test is made with the blue filter. Suppose that sample No. 1, regarded as the standard, reflects .6 of 1 per cent in the blue. The sensitivity control is turned up until the meter indicates the zero or reference point. Thus the .6 of 1 per cent in the blue now has as much effect on the circuit as the 99 per cent of the red when using the red filter.

Suppose further that sample No. 2 has only .4 of 1 per cent blue. In red light or North light it is doubtful if the usual eye inspection would detect this small percentage of blue. However, with the use of the sensitivity control, and the blue color filter, these blues can be tested accurately even although they are a small percentage of the total light reflected under normal conditions. In the cases given, with the zero set for .6 of 1 per cent, there will be a marked change of the indicating instrument when the .4 of 1 per cent sample is tested showing that the latter reflects less blue light.

Similarly, the green color filter is used. A sample which matches, or has approximately the same readings on all three filter colors, will appear identical or "matched" when illuminated with any ordinary color combination of visible light.

*Westinghouse Electric & Manufacturing Company.



The color-matching unit with the cover removed. Fabrics, dyes, inks, paints, powders, and foodstuffs can be compared

✦

Electronic soundings for deep-sea fishing fleet

The first fishing schooner to be fitted with an electronic fathometer is the Boston vessel "Joffre" which returned there recently with 100,000 lb. of halibut. By using the electronic depth-finding apparatus, the "Joffre" was able to take soundings in rapid succession, accurately and while the vessel was under way. In Great Britain the electric depth-finder is being commonly used in the fishing fleet (see also *Electronics*, April, 1932) as the vast majority of fish are bottom feeders. The frequencies used are ultrasonic, about 37.5 kc. per sec. representing waves (in salt water) 4 cm. long.

✦

Extension-cords for phototubes—their limits

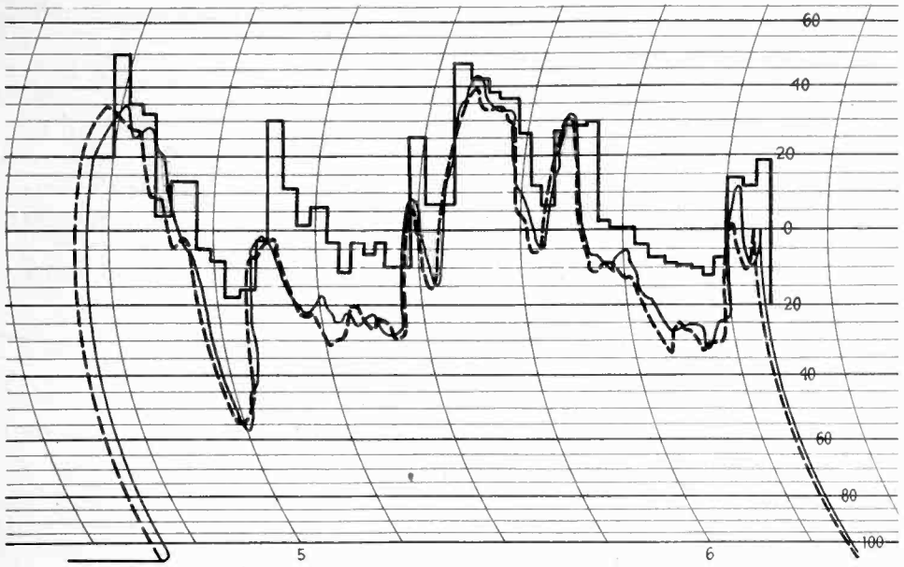
Frequently plant electricians who want to rig up electric-eye installations, cannot understand why phototubes cannot be used on extension cords of any length, at any desired distance from the amplifier panel.

The reason that the length of phototube cable cannot be extended indefinitely without causing a sacrifice in sensitivity, is explained by W. R. King of the electronic sales division of the General Electric Company, Schenectady, N. Y. He says:

"The inter-conductor capacitance constitutes an impedance paralleling the photoelectric tube. Since the impedance of the photoelectric circuit is a good many megohms, it is obvious that the capacitance of the two leads does not have to be large to represent an impedance (at sixty cycles) low enough to effectively short circuit the photoelectric tube. By using shielded cable and taking precaution to keep the inter-conductor capacitance as low as possible, the cable may be increased to many feet if necessary.

"A cable length of four or five feet is suitable for most purposes and can be used without any appreciable sacrifice in sensitivity."

DEVICES IN INDUSTRY



Smooth curves show silk diameter as rapidly recorded by electric eye. Stepped line shows actual weights by tedious painstaking weighing. The two recordings agree within 10 per cent

Testing of raw silks by photocell

THE SILK MANUFACTURERS of America have long recognized that the most important quality of the raw silk as purchased from the Orient is the uniform size or diameter of the thread. Some years ago the famous silk house of Cheney Bros. developed a device called a "Seriplane" for winding samples of the silk purchased, on a block board with about 100 threads to the inch. If the thread was not uniform in size the coarse and fine parts would show up as light and dark bands. These bands would be visually inspected and graded according to their number, width and intensity.

Recently the Cheney Bros. Laboratories have extended the Seriplane by replacing the human eye by a photocell. A beam of light is passed at right angles through a slat in the Seriplane board on which the silk is wound. As the board is carried at a constant speed past the light, the amount of light infringing on the photocell varies inversely with the diameter of the silk thread. The amplifier is arranged with a balanced circuit so that only deviations of the diameter in the thread cause a record to be made by the curve-drawing wattmeter. Thus human errors are eliminated.

✦ ✦ ✦

Photocell safeguards on 58 Radio City elevators

FIFTY-EIGHT ELEVATORS in the great seventy-story skyscraper located between 49th and 50th Sts., in the Radio City section of Rockefeller Center, are being equipped with "Safe-T-Ray," the Westinghouse light-operated device for guarding passengers from injury hazards of fast-moving door panels.

On each elevator two horizontal rays of light are placed in the narrow space between the elevator car doors and the building corridor doors. Carried on the car, and serving wherever the elevator stops, the rays are arranged above the elevator threshold at heights, of respectively, 6 inches and $3\frac{1}{2}$ feet. The lower beam is cut by the passenger's foot entering or leaving the car. The upper beam is cut by the passenger's waist in the event that his feet happen to straddle the lower beam at the time the doors are closing.

Each ray is emitted by a special wafer-type projector located at one side of the doorway, out of sight, and extends across the doorway like an intangible bar about 2 inches in diameter, which strikes a photocell on the opposite side. From the dust-proofed photocell boxes, wires run to the amplifier on top of the elevator cab where the small photocell currents control sufficient energy to operate a small relay in the circuits of the door control relays.

The photocells, through their amplifying apparatus, control the car doors so that upon the presence of a passenger in the doorway they cannot be closed, or if they are closing, the doors reverse and fly open.

At Rockefeller Center it is interesting to note that 58 amplifying tubes, 58 rectifying tubes and 116 photocells, together with their auxiliary apparatus are used in this elevator-door protection alone.

✦ ✦ ✦

"MAGIC DOOR" SHUTS OUT PRINT-SHOP NOISES

The New Britain (Conn.) Herald has installed this door between its print-shop and editorial offices. Light-beams on both sides control door from both directions. H. H. Raymond, Berlin, Conn., was engineer

Dynamic tube measurements

over wide ranges of values

By W. N. TUTTLE
Engineer, General Radio Company

IN MEASURING the three usual dynamic coefficients of the many types of electron tubes now in use, difficulties are met with in several directions. Alternating-current null methods are commonly employed, and the usual troubles associated with these methods are aggravated by the necessity of maintaining the various electrodes at specified d.c. potentials and providing paths for the direct electrode currents. Batteries or power-supply devices tend to increase the stray capacitance effects, which are particularly important when the resistance of the operating electrode is large.

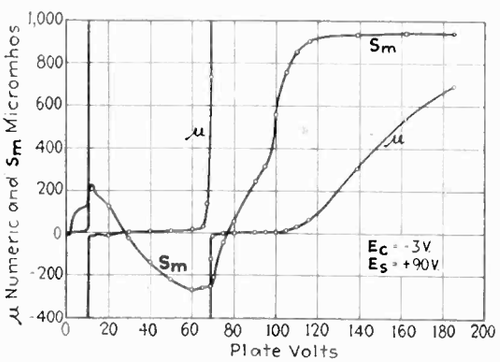


Fig. 1—Amplification factor and transconductance of type 24 tube as functions of plate voltage

Other difficulties are encountered when the attempt is made, for the sake of convenience and simplicity, to measure both very large and very small values, positive and negative, with the same apparatus.

The data to be given, illustrating extensions of the use of dynamic methods, were obtained on a single instrument, the General Radio Type 561-A Vacuum-Tube Bridge, which has recently been developed. The circuits are such that all batteries are at ground potential, next to the cathode, so that the effective stray capacitances are considerably reduced. An improved method is employed for balancing out the effect on the measurements of the stray capacitances which remain, including those between the elements of the tube. In order that the ratio between the two test voltages employed, and consequently the order of magnitude of the quantity being measured, may be varied over wide limits, an independent step attenuator is used in conjunction with each voltage source. Since there are no cases in which a correction term is to be applied to the values read directly from the instrument, such an arrangement permits the measurement of tube coefficients over wide ranges of values without change in the operating technique. Finally, negative as well as positive values of all coefficients can be observed without change of procedure by throwing a single switch, which reverses the phase of one of the test voltages. Further details of the measuring circuits, together with a discussion of the sources of error involved will shortly be published elsewhere.

It will be seen that test equipment having the characteristics outlined can be applied to the measurement of parameters referred to any pair of electrodes of a multi-element tube, since the coefficients for the various electrode circuits differ only in respect to magnitude and sign.

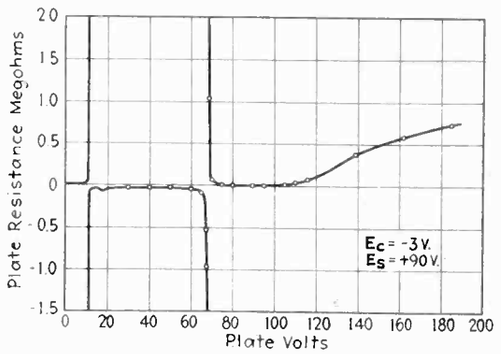


Fig. 2—Plate resistance of type 24 tube as function of plate voltage

A screen-grid amplifier tube (type 24) operated with the usual potentials on the control grid and screen but with various sub-normal plate voltages affords an interesting example of the variation in the coefficients which may be encountered. At low plate voltages the plate resistance becomes negative, passing through points of infinite resistance at each end of the negative resistance region. The amplification factor in this region also passes through all possible values. The transconductance takes on both very small and negative values.

Measurements in the negative resistance region can be made only if oscillation is prevented. The conditions for dynatron oscillation may be simply stated as follows: Oscillation will take place at any frequency for which the reactance of the external circuit of an electrode is zero, provided that the negative resistance of the electrode is numerically less than the external positive resistance at that frequency. Oscillation may be prevented for all conditions, therefore, by making the external plate-circuit resistance less than the minimum negative resistance. This was accomplished in the case described by connecting a resistance of 20,000 ohms across the output transformer of the bridge. This results only in a slight loss of sensitivity and does not affect the measurement of any of the three coefficients.

Figures 1 and 2 show the results of direct dynamic measurements on a type 24 screen-grid tube for various plate voltages. The control-grid and screen voltages were held at —3 and +90, respectively. Several interesting regions of operation are evident. For plate voltages between 110 and 185 there is very little change

in the transconductance, but the amplification factor increases uniformly with the plate voltage. There are no critical or unstable points, and entirely satisfactory operation of the tube is to be expected. It is evident that in this region any desired plate resistance between 30,000 and 700,000 ohms may be obtained, according to circuit requirements, by varying only the plate voltage.

At approximately 77 volts it is seen that the amplification factor, and hence the transconductance, passes through zero and becomes negative. The plate resistance is in the neighborhood of 13,000 ohms and is varying relatively slowly. If there is a small alternating voltage on the control grid, therefore, the alternating plate current will decrease to zero, and then increase with reversal of phase as the plate voltage is varied through this critical point.

In the region of plate voltages between 65 and 70 both amplification factor and plate resistance vary extremely rapidly, the values of both quantities passing through infinity and reversing in sign. In this region measurements of plate resistance were obtainable at 1, 20, and 100 megohms both positive and negative, although these values are off the scale of the curves.

At about 11 volts a similar critical region is observed where the plate resistance again becomes positive. No new phenomena are evident at the lower voltages except that the variation of all three quantities is less regular.

Measurements on grid resistance

In order to test the reliability of the bridge balances and the method of neutralizing capacitance effects, measurements were made of a quantity seldom referred to, a.c. grid resistance at negative biases. Since this quantity depends on residual gas, resistance values are encountered which are enormously greater than those usually measured.

These measurements were made by the method of placing the unknown resistance in parallel with one of lower value which can be directly measured by the bridge. The change in the balance point determines the value of the unknown high resistance.

Figure 3 shows values of the a.c. grid conductance of a type 199 tube obtained in this manner. The plate voltage was held at +45. The fixed resistor used in this case had a value of approximately 43 megohms. With the apparatus employed, balances could be obtained within about 0.1 megohm for resistances in this region. An observable shift in the balance point would therefore be caused by a resistance of 20,000 megohms in parallel with the fixed resistor.

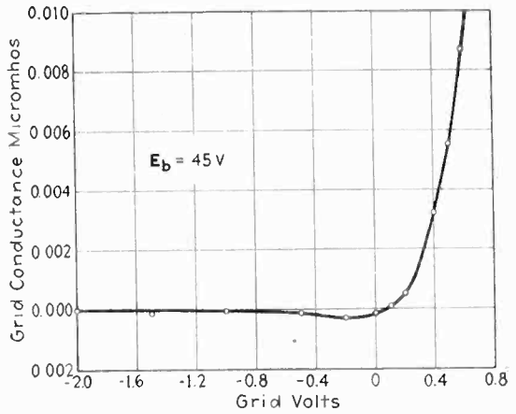


Fig. 3—A.C. grid conductance of type 199 tube

The values given are corrected for leakage and dielectric loss in the base, the latter data being obtained from an additional measurement with the tube unlighted but still warm. The losses were found to be 0.0045 micromhos or 220 megohms.

It is seen that the results are satisfactory even at the very low values observed. The region of negative conductance occurs as is to be expected theoretically whenever there is detectable ionization current.[1]

It is interesting to note that at 1,000 cycles the conductance due to dielectric losses and leakage is considerably greater than that due to residual gas. These losses are readily measurable, therefore, with satisfactory accuracy. The method described has proved most convenient for measuring dielectric losses in insulating materials.

[1] I.R.E. Standardization Report, 1931 Yearbook, p. 158.

▼ ▼ ▼

A study of high-frequency heating

[*Continued from page 340*]

In any method of high-frequency heating it is desirable to have an apparatus which is efficient, has a large range of frequency and is readily controllable. For these reasons, vacuum-tube oscillators are of great interest.

In Fig. 6, the power transformer feeds a four-tube, bridge circuit rectifier which, in conjunction with the filter, supplies the plates of the oscillator tubes with 3,000 volts d-c potential. The oscillators are capable of producing a high-frequency power output of 500 watts each, which is sufficient for the production of fever in man. According to theory, the available power is sufficient to produce a temperature rise of about one degree in five minutes in an average size person. Other things, such as nature's "temperature control," complicate matters so that the results often deviate widely from those predicted.

The oscillator is of the push-pull type which produces an output voltage across the tank circuit about twice that of a parallel arrangement. Since the rate of heating is proportional to the square of the electric field, it is of advantage to have this as large as possible. Two aluminum plates, insulated with molded rubber, are used to concentrate the high-frequency energy in a limited field that may be utilized. The accompanying apparatus for the treatment of man employs a suspension cradle of tapes stretched across a wooden framework and a celotex cabinet to cover the body. Figure 8 illustrates apparatus.

It is unfortunate that Wagner Jauregg, that great Viennese doctor-scientist, is unable to witness the production of fever by this new equipment, with which it is necessary only to place the body in the space between two insulated plates and the temperature may be raised at a rate and to an amount dependent only on the control of the generating apparatus. It is hoped that this safe, controllable method of producing fever by high-frequency electric fields will entirely supplant the dangerous malarial fever which he first used.

electronics

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O. H. CALDWELL, *Editor*

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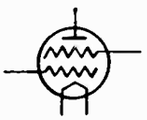


Chiseling the chiselers

COMPONENT parts manufacturers have complained bitterly in recent months of excessive chiseling indulged in by purchasing agents of the larger set manufacturers.

No one who has a broad view of any industry can consider super-chiseling as anything but practices destructive to manufacturing pride and profit, as deterrants to research and experiment, and in the final analysis as adversely affecting quality.

But there is another practice which large-quantity buyers lay at the doors of the components people. Quoting a low price on thousand lots, the parts maker actually make a few hundred more than the thousand, sells these few hundred to small buyers at the same price given the large buyer. The large buyer, getting no advantage by his heavy buying demands a still further reduction in price on his next purchase thereby forcing the price to lower level. Thus the circle is completed.

The "Einstein Piano" and electronic music

THE coming of Dr. Albert Einstein to the United States to serve as a member of the Princeton College faculty will remind many electrical men here that the wizard of relativity has a personal reputation in electronics and electrical invention, quite independent of his mathematical abstractions. His best-known electrical device before the European public is undoubtedly the "Einstein piano," a musical instrument which employs the vibrations of piano strings to actuate microphones, the output of which can then be modified by electrical circuits to produce a variety of instrumental effects when heard through a loudspeaker. By changing switch contacts, various familiar standard instruments can be reproduced, or the player may soar off into new Einsteinian harmonies, creating musical notes of timbres and qualities never before heard in nature.

The Einstein piano is but one of many new electrical musical instruments which are now holding public attention in Europe. Over there a large number of inventors has been at work on electronic devices for individual musical expression. In America a similar instrument just placed on the market commercially is the Emicon, having a keyboard by which single notes can be played through the regular radio-set loudspeaker, either separately or as an accompaniment to an incoming radio program. The $59.50 price at which the Emicon is offered to the public, will give an interesting test of the public's demand for instruments for individual musical expression.

Mechanical troubles in electronic circuits

ELECTRICAL failure in radio and electronic circuits is too often caused by mechanical failure. This is mainly due to wear, inadequate strength, and insecure bracing.

Volume controls, rheostats, loud-speaker moving coils and cones, jacks, switches, and relay armatures and contacts are subject to mechanical wear when in use.

Tube-socket contacts, brittle lock soldering lugs, and insecurely fastened wires, especially when soldered too cold, often cause electrical trouble by their mechanical weakness. Overrated resistors get too hot, and often change their resistance or break, rendering the circuit less sensitive or inoperative. Frequently the fastening and bracing of heavy parts is inadequate.

Too often the electrical designer overlooks these points.

Adequate provision for the normal mechanical wear of moving parts, sufficient strength in bracing, and the proper choice of materials are necessary for the full useful electrical life of electronic and other circuits.

An automobile radio is an "auto accessory"

WHEN is a radio set *not* a radio set? When it is mounted on an automobile, says Uncle Sam. For then, according to the obliging official interpreters of the United States Treasury, a radio receiver is no longer such, in the eyes of the law, but becomes an "automobile accessory," taxable at 2 per cent instead of 5 per cent. Here is the official ruling:

"Automobile radio sets specifically designed and primarily adapted for use in automobiles are considered automobile accessories within the meaning of section 606 (c) of the Revenue Act of 1932 and are taxable when sold by the manufacturer at the rate of 2 per cent under that section, rather than at the rate of 5 per cent under section 607, imposing a tax on certain component parts of radio receiving sets.

"Under section 606 (c) such radio receiving sets may be sold free of tax to a manufacturer of automobiles, who becomes liable for the tax in the same manner as the manufacturer if the sets are resold by him otherwise than on or in connection with, or with the sale of, taxable automobiles.

"When such sets are sold by the manufacturer to a dealer for resale or for installation by him, or to a consumer, the tax is imposed at the rate of 2 per cent under section 606 (c)."

"General Electronics Corporation"

ANNOUNCEMENT of the stock of the "General Electronics Corporation" being traded on the New York Produce Exchange, has resulted in a number of inquiries to this office concerning the corporation. Of course it has no relation whatever to *Electronics* magazine, which has been operated since April, 1930, by the McGraw-Hill Publishing Company.

General Electronics Corporation was incorporated in Delaware, June 16, 1932, and of 2,408,078½ shares of common stock, with a par value of $1 each, 1,051,707 shares are now issued and outstanding. It has as affiliates and subsidiaries, the Electronic Research Corporation, with a laboratory at 47th Avenue and the East River, Long Island City, N. Y. Aeradio Corporation of America, which took over the radio-aircraft business and laboratories formerly operated by Harold Herbert; and the Shortwave & Television Corporation, with patents of Hollis S. Baird and others. Officers listed are: Col. Harry L. Spencer, president and treasurer, Oscar C. Bohlin secretary, and Stanley L. Juthe, director, in addition to the officers. The executive office is given as 6 Jersey St., Boston, Mass.

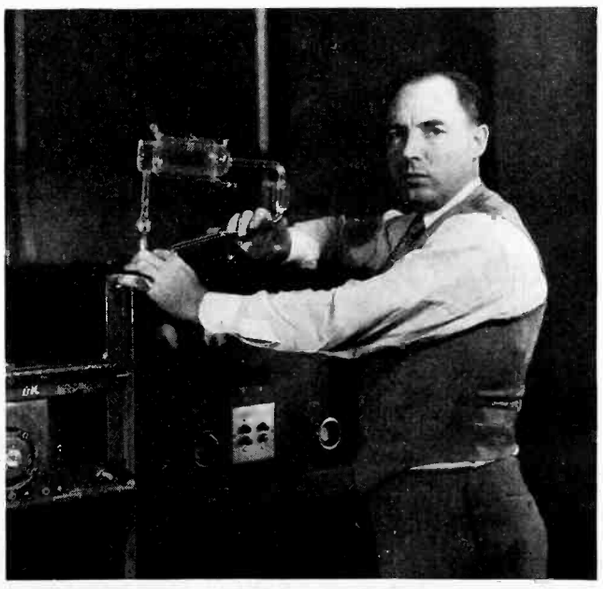
On the trail of "cold light"

INVENTORS continue to hammer away at the problem of more efficient electrical illuminants, and already it is apparent that the light of the future will be the glow of gases in tubes evacuated to low pressures.

One of the most interesting of these "cold light" experiments is that exhibited last month at New York by Elman B. Myers, well-known radio pioneer and early maker of the three-element audion. Using a quartz tube of special shape containing a small quantity of mercury, Mr. Myers made this tube glow in the focus of an induction coil, as a 3,000-candle power lamp. Another tube slightly larger, which he showed, is capable of giving out 250,000 to 500,000 candle power, he reported, and with an efficiency of 24 candle power per watt, making his new illuminant twenty times as efficient as the tungsten-filament lamp. Mr. Myers suggests that the extreme light intensity secured results from the actual disassociation of the mercury atoms, the knocking of an electron out of the atomic system.

While the new light was exhibited primarily as a source for television, to which it is well-adapted by reason of its sensitiveness to high-frequency modulation, the greatest opportunity would seem to lie in illumination, street lighting, flood lighting, studio lighting, etc., providing its auxiliary exciting apparatus can be simplified.

NEW TELEVISION LIGHT-SOURCE



Elman B. Myers and his 3000-cp quartz-mercury lamp. Operated in the focus of a high-frequency induction coil, it delivers 24 candle power per watt

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Radiothermy

[W. R. WHITNEY] A review of the subject presented at the International Electrical Congress, Paris, France, July 4-12, 1932, with 25 references.—*General Electric Review, August, 1932.*

✦

Image details and optical systems in television reception

[E. BUSSE] Zeiss-Ikon Dresden. A photographic picture is considered satisfactory when differences of 25 per cent in brightness are rendered in the darkest portions, and differences of 5 per cent in the bright portions. For normal picture a range of 1:120 is sufficient, or as the lowest input voltage must exceed 10 microvolts to be above the "noise" level, the largest input voltage must be above 1.2 millivolt. About 10 to 100 volts are required at the grid of the output stage for controlling the glow discharge current, or the cathode ray tube current, and several times more for the Kerr cell, corresponding to four or six stages of amplification. For satisfactory reproduction in a darkened room a negative glow neon lamp used with a scanning disk can take care of 4,700 elements, a sodium positive column lamp of 27,000 picture elements, the size of the pictures depending only upon the area of the glow. The cathode ray tube gives figures of the same order, the size of the picture depending on the size of the ray spot. Point sources as used with mirror drums or lens disks give about ten times brighter images, the size depending on the area of the source and the optical arrangement. For projected images point sources and lens disks seem to be most promising for pictures 9x12 cm., Kerr cells for areas of 6,000 sq.cm. *Zeitschr. techn. Physik, July, 1932.*

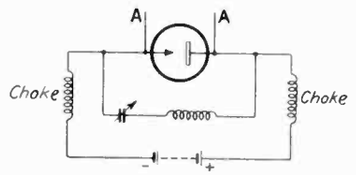
✦

The Derby by television

[EDITORIAL] Two thousand people watched the Derby on June first from the Metropole Cinema, London. The famous parade was seen horse after horse. Details were lacking, and someone was heard to remark that the horses looked more like camels. When Mr. Baird showed himself on the stage he was greeted with tremendous applause. The optical system consists of a mirror drum with 30 mirrors making 750 r.p.m. Kerr cells were used in the receiver. The screen was 9 ft. by 7 ft.—*Electrican, June, 1932. Discovery, July, 1932.*

Radio patents

SHORT-WAVE tube generator. German 535367. The tube contains two cold electrodes, the negative one taking the form of a sharp point, thin wire or the like. A very high vacuum is used, and some 100,000 volts applied. The *E/I* curve of such a tube is very steep, and under suitable conditions shows negative resistance, making its use as a generator possible in such a circuit as that shown,



where A, A are short antennas connected directly to the electrodes.

Temperature Compensation with Piezo-electric Crystals. German 549067. A condenser whose capacity varies with the temperature (e.g. two electrodes separated by a distancing-piece which expands and contracts with change of temperature) can be connected in series or parallel with the crystal, or the variations in dimensions (e.g. of a bi-metallic strip) can be made to rotate a variable condenser vane thus connected.—*Funktechnische Monatshefte, Berlin, August, 1932.*

✦

Photoelectric relays

[W. R. KING] General Electric Company. Many machine designers and plant engineers have learned that they are justified in considering the beam of light along with their cams, levers, limit switches, and other mechanical contrivances. In one type of available relays the output current of the pliotron amplifying tube energizes the coil of a sensitive relay which in turn controls a contactor. The photo-tube is mounted in a separate housing connected to the amplifier by a flexible cable of low capacity. The user may adjust the device to suit the amount of light by varying the grid bias. In another type of relay the contactor remains open so long as the illumination is above say ten foot-candles but will close when a drop of 40 to 50 per cent takes place. Units for a.c. and d.c. operation are available. For speedy operation magnetic relays are replaced by grid-controlled rectifiers, but the light impulse or interruption is only measured if it is longer than one cycle of the supply feeding the thyratron.—*Gen. El. Review, August, 1932.*

Tubes for wave-lengths between one and six m.

[L. ROHDE] University of Jena. Obtaining 10 watts from a tube sending out one-meter waves is more difficult than getting 10,000 watts at six meters, the reasons being incorrect phase differences when the time for traveling from filament to plate becomes equal to the duration of one-half cycle, the low external load in contrast to the high internal resistance of the tube, and insufficient cooling on account of the small size of the electrodes. Tubes with considerable mutual conductance and low internal resistance (indirectly heated) are good oscillators. To reduce internal capacities special tubes were constructed that had the electrodes supported on quartz or glass rods. A water-cooled one-kw. tube for one-meter waves is described. — *Hochfrequenztechnik and El. akustik, July-August, 1932.*

✦

Improved batteries according to recent patents

[L. JUMEAU] A review of the improvements in the construction of dry and wet cells with special reference to French patents.—*Revue generale de l'electricite July, 1932.*

✦

New radio-frequency coils with magnetic cores

[SCHW] "Ferrocart" is a new material for such cores, consisting essentially of a pulverized magnetic alloy in suspension in a suitable isolant so that the particles are nowhere in contact with one another. The resultant material is then spread in a very fine layer on thin paper, several thicknesses of this being pressed into adhesion to give the necessary mechanical strength, and formed into plates or tubes, etc., as required. Damping of such coils is less than with any other type, and dimensions for equivalent inductance are very greatly reduced, thus incidentally facilitating screening.—*Funk, Berlin, August 26, 1932.*

✦

New radio antennas

[KELLER] The new short-wave antenna at Königswusterhausen consists of four rectangles mounted vertically one above the other, each being in a horizontal plane, and each fed from two opposite corners.—*Funk Mazazin, Berlin, September, 1932.*

A field intensity meter

[G. H. Brown and Glenn Koehler] University of Wisconsin. The carrier voltage induced in the loop circuit is amplified through three stages of tuned radio frequency. A local oscillator is then introduced, its frequency being such that a beat note of about 1,000 cycles is obtained in the first detector. The amplitude of the note is proportional to the product of carrier and oscillator amplitude. Amplified it gives an increase in plate current flowing through a second detector. The loop is then removed and the calibrating oscillator and attenuator attached, set at the frequency of the transmitting station and adjusted to give the same reading of plate current in the second detector. The advantages are: considerable amplification, high sensitivity and selectivity.

Another portable field strength measuring equipment weighing 180 lbs. is described in the *Marconi Review* May-June, 1932.—*Review of Scientific Instruments, August, 1932.*

✦

On superregeneration

[Egerland] Study with useful bibliography, and dealing more especially with the reception of telephony. The deformation frequently met with is usually due to the use of too low a superregenerative frequency used to get greater amplification. On the short and ultra-short waves this difficulty does not arise, since the difference between the two frequencies is already great even with a relatively high quenching frequency. Special attention is given to the characteristic noise heard when the receiver is not tuned to a carrier, and the cause is considered to be irregularities in the periodical quenching and re-starting of oscillations, due to small variations of filament and anode voltages, atmospherics, etc. As soon, however, as a carrier-wave is tuned to, the action becomes regular and consequently the noise ceases. The poor selectivity of a superregenerative receiver is discussed.—*Funk, Berlin, August 12, 1932.*

✦

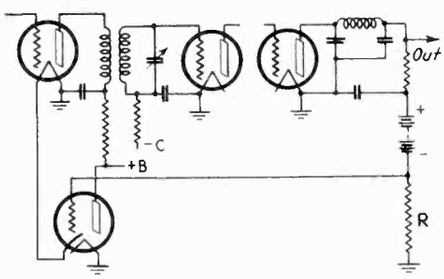
New 60 kw. transmitter Poste Parisien

[Jean Leduc and Roger Sallard] Poste Parisien. On the occasion of the official opening of this new station (328 m.), which belongs to the Compagnie Generale d'Energie Radio-electrique, sound and pictures were simultaneously broadcast April 25, 1932, for the first time in France. The transmitter is located 20 miles from the studio on the avenue des Champs Elysees, so that in the whole city 10 millivolts are received. Phase modulation according to the Chireix system is employed, its efficiency making possible a saving of about 80 kw. on 300 kw. Instead of applying amplitude modulated high-frequency voltage, a completely modulated high frequency voltage is applied to the grids of the last stage in quadrature with an unmodulated high frequency voltage. The resultant voltage varies in phase but remains constant in absolute magnitude. The circuit consists of two identical halves. The cut-off of the telephone lines is at 17,000 cycles, their attentuation is practically constant between 50 and 8,000.—*Revue generale de l'electricite, July-August, 1932.*

✦

Radio patents

[Di] Fading Compensation. German 525207 in which the change in anode current of the tube 3 (detector) changes by means of the resistance R the emis-



sion of the tube 1, this altering the filament-heating of the tube 2. The range of correction is from 1 to 1,000.—*Funk Magazin, Berlin, September, 1932.*

✦

Successive reflections versus directly bent ray

Foersterling and Lassen, of the University of Cologne, have studied the question whether the long ranges obtained with 10 or 30 m. waves are due to the directly bent ray, or to successive reflections of rays between the ground and the 220 km. layer, strongly bent rays thrown back to earth after a short path in the layer. Taking into account the curvature of the earth and of the layer the detailed equations for the propagation of the waves do not give a measureable strength at 5,500 km. distance for a single reflected 20 meter-wave emitted by a 1 kw. sender at 5,500 km. distance. The paths with two and three reflections at the layer give about 10 microvolts per meter. These and the following signals ought to be separated by 0.3, 0.7 and 1.1 milliseconds, values which agree with the experimental results, at least as to the order of magnitude (Rukop, Eckersley). In reality the intervals vary up and down, and it seems certain that there are stronger and weaker patches in the layer. Whether excessively narrow beams have an advantage is therefore uncertain.—*Zeitschrift techn. Physik, November, 1932.*

Earthed open receiving aerials

[F. M. Colebrook] National Phys. Lab. The aerial is assumed to have a uniform resistance R, inductance L and capacitance C per unit length. Theory and experiment show that resonances (zero reactance) are given by the equation: wave length equals $(4\ h/n)\ (1 + Ah^2)$ where n is a whole number and A is a small factor, h the actual length of the aerial. The resistance has the value $RH/2$ when n is odd and a very high value when n is even. H is about 5% larger than h. The actual variation of the impedance was determined as a function of the frequency. On considering the working of different parts of a receiving aerial it is found that in an L-aerial short compared with the wave length the addition of a down-lead from the open and nearly to the ground may increase the emf.—*Journal of the Institution of Electrical Engineers, July, 1932.*

✦

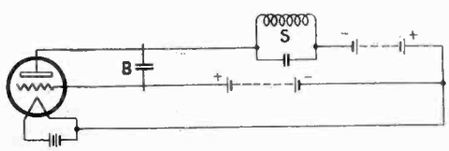
Band frequency amplifiers

[Drouin] The author examines the problem without use of the theory of filters, and from a purely mathematical point of view, taking into consideration from the start the ohmic resistances which are bound to exist instead of at first neglecting them and later introducing corrections. After this discussion, it is shown how the results obtained allow of the immediate determination of the optimum decrease of high and low notes and of the optimum selectivity obtainable with a given amplifier, and curves are given allowing of the rapid calculation of the values needed to produce them. Finally, a considerable part of the study is devoted to amplifiers intended to compensate the distortion introduced by the tuning system.—*L'Onde Electrique, Paris, May and June (published September 3), 1932, and to be continued.*

✦

Radio patents. Self modulation of Barkhausen-Kurz transmitters

[L] French 700544. The circuit S has a natural frequency other than that of the tube-generator, and which can be



in the radio or audio band as desired. B is the usual condenser bridge used to tune the Lecher-wire system to the frequency of the tube.

Measurements on path lengths

FOR COMPUTING THE PATH OF the waves, values for the number of free electrons and ions have to be deduced from experiments in which the height of the layer is measured from echo experiments. Two main methods are in use, the frequency-change method in England and the group-retardation method in America. Quite recently Professor E. V. Appleton and G. Builder have devised a circuit by means of which frequency changes and signals may be obtained from the same setup and the advantages of the methods compared. For best results the pulses must not be over 0.0001 sec. long and spaced perhaps 0.002 sec. apart. It has been found that if the grid leak of an ordinary continuous wave transmitter is increased to a high value, the generator automatically produces the desired short pulses of high frequency energy alternating with even pauses of quiescence.

By inserting a switch S and a small variable condenser across a few turns of the anode inductance the same circuit can be used for the frequency change method. During the night of July 15-16, 1931, both methods gave at times a height of 110 km. (region E) for 80 meter waves, but much more often 200 km. (region F) and even 500 km. in the dark morning hours. At night the region F contains slightly less than half a million electrons per cu.cm. The group method is more reliable than the frequency change method when multiple echoes are obtained, the reverse is true when work is being carried out close to the transmitter, or when it is necessary to know the relative phases of ground and downcoming waves.—*Proceed. Phys. Society, January, 1932.*

✦

How many ionized layers?

THE ANSWER IS THAT the number to be considered depends on the wave-length. Waves shorter than 70 or 100 m. penetrate to heights of about 220 km. before appreciable deflection takes place, whereas waves longer than 300 m. are commonly reflected by a layer at 100 km. altitude. There may even be a third layer at 340 km. containing free positive and negative charges. In view of the increasing interest in short waves the difference in behavior (See *Electronics* editorial, August, 1931) becomes of importance. Such an ionized layer may act in two ways; it bends the waves, and it attenuates them, and which of these influences prevails depends on the wave-length used, the number of charged particles and the density of the air. The free electrons in the layer are set in motion by the wave, and when air is present their motion is interfered with just as in a gassy tube, and the energy borrowed from the wave is lost in friction. At 100 km. the mean free time between collisions is about one millionth of a second, and still higher up the electron can perform many oscillations without being disturbed. If its period is sufficiently short the wave is merely bent, not weakened as would be the case for 1,000 m. waves. When for any reason the number of free electrons decreases evenly throughout the atmosphere, the waves in the regular broadcast band will suffer less absorption, but at the same time the waves below 100 m. will have to travel to much greater heights before being bent back, their strength will decrease on account of the longer path. Waves shorter than 9 m. do not return to earth so that the primary or ground wave only is useful.—(H. M. Dowsett, Marconi Company)

Effect on picture transmission

When the 1928-1929 observations on picture transmission between Somerton (England) and New York were used as a basis to estimate the best wave-length in 1930-1931, the waves selected proved to be too short, especially during the night. A set of accurate measurements over 12 months, up to September, 1931, confirmed the conclusion that at the present time of fewer sunspots there is a progressive increase each year in the values of short wave-lengths which give best results. From March to June, 1931, a new group of echo tests in picture transmission on 15 m. and 30 m. took place betwene Somerton and Montreal, and Somerton and Cape Town which also showed that the density of the charges has fallen considerably from the 1928-1929 values. In the evening the echo is strong, whereas in the early morning hours when the effects produced by the sun are at their lowest the signals are almost free from echo, there is distinctly less reflection. The shorter the wave the weaker the echo. There is also less trouble on the Somerton-Cape Town path which is mostly over land (9,500 km.) than on the Montreal journey (5,500 km.)—*Journal of the Television Society, December, 1931.*

✦

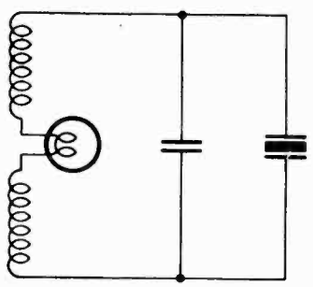
Two-element band-pass r.f. filters

[R. T. BEATTY] Resonance curves for capacity, inductance or mixed coupling, when drawn as a function of $a = 12.56\ \Delta f L/R$ (where Δf = frequency off resonance are completely determined when the ratio b of coupling reactance to the resistance R at different r.f. of the identical coils is known. All practical r.f. band pass filters may be replaced by a theoretical circuit in which the emf. drives current through a complex resistance rR/b, where $r = 2a - j\,(1 - a^2 + b^2)$. The ratio of input to output voltage is $2b/r$, and can be plotted as a function of a for a series of b. This master curve readily gives the resonance curve as a function of the frequency of resonance for any given case, allowing the best values of b and therefore of the coupling reactance to be chosen. By means of a second master curve given in the paper the elements of the coupling branch may be deduced. —*Wireless Engineer, October, 1932.*

✦

Wavelength measurements with ultra-short waves

[LEITHÄUSER AND PETRZÍLKA] Communication from the Heinrich Hertz Institute. The use of quartz or tourmaline crystals in neon or other gas to give a luminous indication at resonance with an oscillating circuit presents great difficulties on the ultra-short waves (continuance of glow after passing resonance, critical coupling, etc.). After discussing some methods for removing these difficulties, not on the whole satisfactory, the authors propose the use of a tourmaline crystal in parallel with a tuned circuit of approximately the same frequency as the crystal, and containing a glow-lamp. When this is coupled to an oscillating circuit the frequency of which is changed slowly, the glow-lamp will light up at a frequency approaching that of the crystal, but at the exact frequency of this it will absorb so much energy that the lamp will cease to glow. The degree of accuracy at a frequency of about 15×10^6 cycles per second, as observed by the eye, is about 2/100,000. Greater accuracy can be obtained by observing the glow with a photometer. A harmonic of the crystal-frequency can also be used, the even ones being more readily obtainable. For extreme accuracy the temperature coefficient of the crystal must be taken into account.—*Funktechnische Monatschefte, Berlin, September, 1932.*



✦

Results of the Breslau antenna

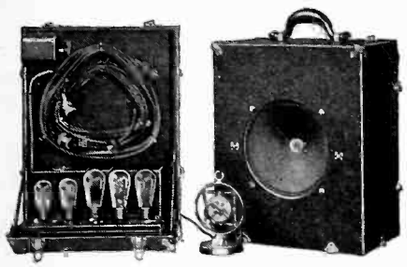
THE "ANTI-SPACE-WAVE" antenna (See *Funk*, July 8) at Breslau is giving excellent results. At 80 km. the fading was in the ratio 1:2 maximum (and rarely over 1:1.2) as compared with 1:30 with the normal antenna; at 160 km. 1:12 (average 1:3) as against 1:50. Good reports of distant reception have been received, e.g. from Greece and Finland.—*Funk, Berlin, September 30, 1932.*

✦ NEW PRODUCTS

THE MANUFACTURERS OFFER

Amplifier equipment

MODEL PAS-347 electric portable sound amplifying system, consists of a single, compact, portable case with a 3-stage amplifier having push-pull pentodes in the output stage. Either 27 or 56 tubes can be used in the first or second stage.



A dynamic speaker is mounted in the detachable section. This can be located at any desired distance from the amplifier and microphone. A double button carbon microphone with desk stand and 12 ft. cord with plug is part of this equipment.

For 110-V-50/60 cycles, the list price, less tubes, is $155.00; 220-V-50/60, $162.50; 110-V-25/40, $165.

Model PAS-50 is similar in construction but is larger in size and more powerful. It lists at $205, $212.50 and $215.

Model DSP-10, portable electric phonograph, is a matched companion unit to the portable PAS systems. It is equipped with dual speed motors, plays 10 or 12 in. records at 78 r.p.m., and the new long playing records at 33⅓ r.p.m. $75. Webster Electric Co., Racine, Wis. —*Electronics, November, 1932.*

✦

Automatic tone correction

A NEW TAPPED BRADLEYOMETER is announced by the Allen-Bradley Company, 1311 South First St., Milwaukee, Wis., which provides automatic tone correction with volume control. It is well known that the sound pressure representing the threshold of audibility varies greatly with the frequency and is a great deal higher at low and high frequencies than in the middle register. Therefore a type of volume control is necessary which varies the frequency characteristics of the audio amplifier so that the apparent quality of reproduction remains the same for all volume control settings. The new tapped Bradleyometer achieves this result in any one of several audio frequency networks and automatically accomplishes tone correction with volume changes.

The resistance element of the tapped Bradleyometer consists of 50 individual resistance steps molded in disc form and stacked alternately between metal discs of somewhat larger diameter. The contact arm makes contact along the edges of the large metal discs, and therefore the resistance units are subject to no mechanical wear. Controls can be provided with a logarithmic resistance-rotation curve to provide uniform decibel increments with knob rotation.—*Electronics, November, 1932.*

✦

Automatic English-reading tube tester

A PORTABLE OR COUNTER TYPE "Confidence" automatic, English-reading tube tester can be obtained from the Burton-Rogers Co., 755 Boylston St., Boston, Mass. This tester provides for the testing of the new seven-prong tube and additional selective positions and switch

points are provided for future tubes so conversion can be made inexpensively.

Model 4, the portable type, is housed in a leatherette case with removable cover, size 5x9x14 in. Model 5 is for counter display use only. The net price to the dealer is $39.50 for either model. It is made for 110 volt, 60 cycle only.—*Electronics, November, 1932.*

✦

Noise eliminator for antenna

DESPITE THE PRESENT WIDE INTEREST in shielded antennas, simple shielding is difficult to handle properly because the normal impedance of the antenna is so high relative to the reactance between the lead-in wire and the shield, unless the shield is widely separated from the wire, that the signals from the antenna are effectively shorted to ground in the shield. The antenna through the Radioformer, marketed by the Pacent Electric Company, 91 Seventh Ave., New York City, presents an impedance to the lead-in which is below the reactance between the wire and this shield, thus reducing the transmission loss in the shielded lead to very little. This small loss, together with the loss in energy due to the lack of pick-up by the lead-in, is in most cases more than made up by a greater transfer of energy from the antenna to the radio, caused by the better matching of the antenna to the radio set. In many cases the received signals are declared to be actually much louder with the Radioformer, which is built to designs worked out by Amy, Aceves & King, Inc., in collaboration with the engineering department of the Pacent company.—*Electronics, November, 1932.*

✦

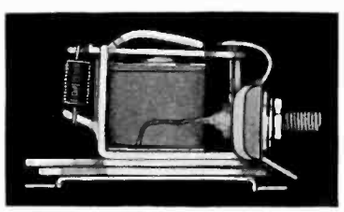
Vulcanized fibre

A NEW FOUR-PAGE BOOKLET describing the fabricating of hard vulcanized fibre and of laminated phenolic materials, has been issued by the Spaulding Fibre Company, Inc., of Tonawanda, N. Y. This is made up in convenient form and presents interesting information on the shearing, sawing, punching, turning, drilling, threading, tapping and forming of these materials. The information is available to engineers or others who may be interested.—*Electronics, November, 1932.*

✦

Auto radio B eliminator

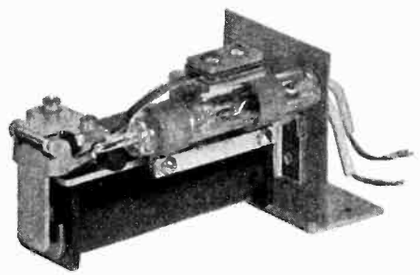
ELECTRONIC LABORATORIES, 122 West New York St., Indianapolis, Ind., are marketing a new automobile radio B-battery eliminator which is completely automatic in operation and minimizes wiring. An "automatic load delay" circuit gives full protection to the mercury-



vapor rectifier tube, as well as the interrupter, insuring long life. The steel container is cadmium-plated and is small in size, measuring ⅜ in. in length, 6 in. in depth, and 2⅝ in. high. There are no rotary parts, and no adjustments are necessary. Any service man can assemble the eliminator in an hour from the kit which, knocked down, sells for $13.25. The unit as assembled at the factory is priced at $17.70.—*Electronics, November, 1932.*

Vacuum-contacting a.c. relay

A NEW VACUUM CONTACTING alternating-current relay has recently been placed on the market by Automatic Electric Company, 1033 West Van Buren St., Chicago. This is a standard relay of proven reliability, long used in automatic telephone apparatus, but modified to accommodate a vacuum contactor. The contactor can open and close circuits carrying up to 6 amperes at 110 or 220 volts. The break takes place in the vacuum inside the contactor, thus definitely preventing all danger of ignition of gases, dust, etc., which might



be caused in certain locations were the contacts exposed. This vacuum contactor will be applied also to other types of relays of Automatic Electric Company's manufacture for direct-current operation, and for various mountings.—*Electronics, November, 1932.*

✦

Keyboard electronic musical instrument

EMICON, INC., 2 W. 46th St., New York City has put on the market its new "Emicon," a compact electronic musical instrument of the monophonic or "solo" type, having a keyboard of 32 notes arranged according to the standard musical "tempered scale." It is so designed that it may be attached directly to the audio stage of any standard radio receiving set, public address system, talking motion picture amplifier or any other similar equipment. By simply turning a button, the tone quality may be varied from that of a string instrument, simulating a violin, or to other qualities which simulate brass and reed instruments such as the horn and saxophone. The range of thirty-two keys covers the range of the average solo instrument. The music produced by the Emicon may be overlaid on incoming radio programs and, with very little practice, excellent harmonies may thus be produced by almost anyone.

The Emicon has an audio oscillator of the gas discharge type, with the keys making contact in series with the main circuit through resistors of the proper value to produce the pitch of each note. The tone quality is secured by filtering out overtones by means of a tone control identical in principle with that regularly used on a radio set. By the use of a potentiometer as a tuning button, the pitch of the entire instrument may be raised or lowered over a range of five full notes, thus enabling the player to tune in to correct pitch on incoming radio program or alter the pitch to accommodate a voice accompaniment.—*Electronics, November, 1932.*

✦

Low-range recording milliammeter

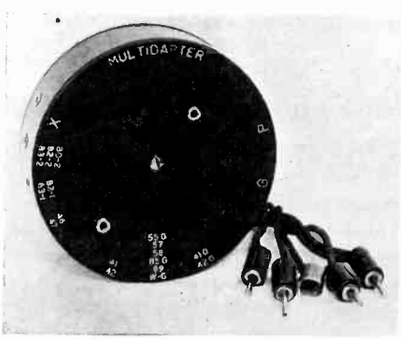
A GRAPHIC MILLIAMMETER of the strip-chart type having the exceedingly low range of 5 milliamperes for full scale, is announced by The Esterline-Angus Company of Indianapolis, Ind. This instrument is direct-writing and contains no auxiliary amplifying equipment. The values are measured by a D'Arsonval element of high accuracy, which has sufficient torque to operate the writing pen over a chart $4\frac{1}{2}$ inches in width.

This instrument will be of special interest to radio, sound and projection engineers, as it provides a means of continuously recording the current in the plate circuit of a vacuum tube. The instrument is adapted to recording modulation, volume-level, sound intensity, light intensity, vibration, and for any other purpose where an accurate record is required of the output of an amplifier. It is particularly adapted to the monitoring of broadcast stations, public address or centralized radio systems, and sound-movie installations. These instruments are made in portable, wall and switchboard types.—*Electronics, November, 1932.*

✦

Multidapter

EFFICIENT AND EASY to use, the "Multidapter" of the Radio City Products Co., 48 West Broadway, New York City, combines many adapters in one. It tests all the new tubes such as 29, 33, 55, 57, 58, 64, 82, 83 and 89 and second plate of



80's, etc. Provision is made for testing new tubes which may be brought out in the 4, 5, 6 or 7 prong types. It is a Bakelite product, sturdily built, neatly engraved, and complete with connectors. —*Electronics, November, 1932.*

Power-factor correction of luminous-tube signs

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has announced a new line of capacitor-transformers for correcting low power factor in existing luminous-tube sign installations. The new unit consists of a capacitor assembled with an air-cooled auto-transformer which steps up the supply voltage to a value permitting the most economical capacitor design. Studies have shown that such a combination is more economical than a capacitor alone, connected across the low-voltage supply, as this would require a much larger amount of capacitance.

The capacitor-transformer is connected directly across the primary supply line and can be used to correct the power-factor of a group of signs. On some large installations it is more economical to use the capacitor-transformers together with standard luminous-tube transformers, than to use individual high power-factor transformers.—*Electronics, November, 1932.*

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Oscillograph accessories

ALLEN B. DUMONT LABORATORIES, Upper Montclair, N. J., have added to their line of cathode-ray tubes an inexpensive power supply shielded tube holder and sweep circuit to be used in conjunction with its Type 34 oscillograph tube, operated from the 60-cycle mains.

Means are provided on the power supply for adjustment of the voltage on the filament, focusing electrode and accelerating electrode. A meter is arranged to insure against excess filament voltage. The sweep circuit has controls for amplitude position of the figure and synchronization. The sweep frequency range is from 10 to 15,000 cycles per second. All necessary cables and plugs are provided with the equipment.—*Electronics, November, 1932.*

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Crystal loudspeakers

THE BRUSH DEVELOPMENT COMPANY, 3715 Euclid Ave., Cleveland, Ohio, has begun the marketing of a number of new piezo-electric devices for the radio and public-address fields, based upon its well-known development of large crystals of Rochelle salts. As these devices are voltage-operated they require no field current or polarizing voltage. The PA-4 and P-12 units are driven by four of the regular crystal motors, and are designed respectively for use with ten-foot air-column and with horn-type baffle. The exponential unit has a remarkable range, responding from 60 cycles to 10,000 cycles. The P-12 speaker, in addition to its use as a single unit, can be connected in parallel with a dynamic unit, increasing entire range of installation.—*Electronics, November, 1932.*

U. S. PATENTS
IN THE FIELD OF ELECTRONICS

Electron Tubes

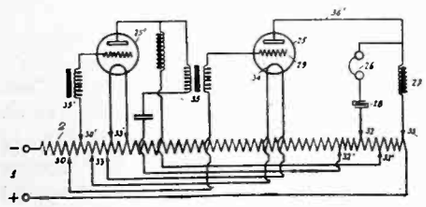
Voltage regulator. Gaseous tube comprising a cathode and anode and a source of alkali metal vapor so arranged that a glow discharge is maintained at a substantially constant voltage. P. L. Spencer, assigned to Raytheon, Inc. Filed March 15, 1928. No. 1,878,341.

Thermionic system. Combined rectifier and triode in the same bulb but isolated from each other. J. E. Foster, assigned to R.C.A. Filed January 8, 1925. Divided and filed June 5, 1929. No. 1,878,124.

Electron emitting device. A cathode mount having a reverse wound bifilar helical filament mounted inside an insulator. W. J. Albersheim, assigned to R.C.A. Filed June 19, 1926. No. 1,878,089.

Controlled rectifier. A gaseous discharge having arc-like characteristics and an anode, cathode and a cup-shaped perforated control electrode closely surrounding the cathode. A. W. Hull, assigned to G. E. Company. Filed April 10, 1928. No. 1,880,092.

Energizing vacuum tube. Circuit in which a continuous resistor is placed across a d.c. source. Various voltages are picked off of this resistance to light the filaments of tubes, to bias the grids, and furnish positive potential for the plate. W. V. B. Roberts, assigned to R. C. A. Filed Feb. 11, 1928. No. 1,882,920.



Thermionic relay. Three-electrode tube comprising a cathode, an anode and a control element comprising an induction coil interposed in the path between anode and cathode and arranged to magnetically control the electron emission. H. F. Breckel, Cincinnati, Ohio. Filed March 31, 1928. No. 1,883,520.

Gaseous rectifier. Gaseous discharge tube for rectifying both halves of an a.c. current ranging in voltages between 80 and 400 volts, having a filling of rare gas at a pressure lying between 0.5 and 5. mm. of mercury, in which the anodes are of relatively great radius of curvature compared with the cathodes. Means are provided for protecting the anode conductors from being struck by positive ions. E. Oosterhuis and J. G. W. Mulder, assigned to Philips. Filed July 11, 1927. No. 1,882,032.

Photo-electric cell. Tube having an anode and cathode, said cathode comprising nickel platinum alloy and a light sensitive element comprising lithium deposited on the alloy. H. E. Ives, assigned to B.T.L., Inc. Filed March 7, 1929. No. 1,881,616.

Radio Circuits

Superheterodyne receivers. Radio-frequency amplifier with a response which rises with increased frequency and an oscillator having a response which decreases with increased frequency, so that the response of the receiver is uniform over the frequency range. W. A. MacDonald, assigned to Hazeltine Corp. No. 1,881,235. Filed Feb. 13, 1931.

Untuned amplifier. Combination of an untuned radio-frequency amplifier and a frequency-selecting arrangement, the entire circuit arranged so that the system is selective and free from cross-talk. W. A. MacDonald, assigned to Hazeltine Corp. No. 1,881,284. Filed Dec. 1, 1930.

Remote control system. A system of broadcast reception, including a method of amplifying a wide band of frequencies and re-radiating them to an aperiodic receiver. Wilson Aull, Jr., Astoria, N. Y. Filed Dec. 30, 1927. No. 1,881,395. See also Nos. 1,881,391, and 1,881,392 to Bowden Washington and Wilson Aull, Jr., on remote control receivers.

Power circuit. Method of operating multi-stage resistance-coupled amplifier from a source of current of varying voltage so that the current variations in the plate circuit of the last tube remain less than a disturbing value by opposing the variation in grid potential. H. R. Hayden, Brooklyn, N. Y. No. 1,881,357. Filed Aug. 15, 1928.

Wave transmission. Method for transmitting and receiving radio signals by means of wave conductors consisting of coils with adjacent metallic shields. W. R. Blair and Louis Cohen. Patent Nos. 1,884,536, 1,884,537. Filed Nov. 24, 1928 and Jan. 15, 1929, respectively.

Inductive tuning. A multi-stage transformer coupling radio frequency system in which the primary of the interstage transformer has fixed and variable portions. F. L. Lord, Newark, N. J. Filed Feb. 1, 1926. No. 1,884,011.

Synchronizing system. Method of operating several radio transmitters with common carrier frequency comprising detecting both stations at a point where the field strength of the wave from the transmitters are approximately equal, transmitting the detector signals from one transmitter and adjusting the frequency of the carrier wave of that transmitter to substantially eliminate the beats. G. D. Gillett, assigned to B.T.L., Inc. Filed June 10, 1930. No. 1,881,483.

Phase modulation. In a system of radio telephony two independent sources of the same frequency but presenting a predetermined phase difference of approximately 150 degrees and means, including saturated induction coils, for varying the phase difference by microphone currents. Henri Chireix, Paris, France. Filed May 6, 1927. No. 1,882,119. Editor's Note. According to semi-technical publications this system of phase modulation effects considerable economies in operation. The new Paris station of 60 kw. in power is said to utilize this system.

High-frequency oscillation. A high power generator of oscillation of short wave lengths comprising a plurality of separate generators. E. F. W. Alexanderson, assigned to G. E. Co. No. 1,866,337.

Receiving system. Method to receive waves of less than one meter length comprising a reflector, a dipole adjacent to said reflector, and an energy feed line coupled to the dipole, and symmetrically adjusting the feed line for tuning the circuit. Fritz Schröter, assigned to Telefunken. No. 1,866,271.

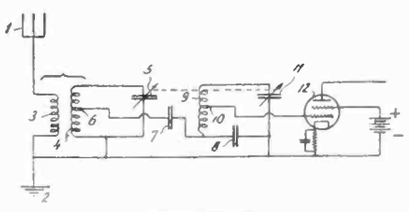
Eliminating fading on short wave lengths. Method of combining the output of two antennas and receivers. H. H. Beverage and H. O. Peterson, assigned to R. C. A. No. 1,874,866.

Ultra short-wave antenna system. A conductor several wave lengths long having U-shaped loops one-half wave length long and a parabolic reflector. C. W. Hansell, assigned to R. C. A. No. 1,874,983.

Eliminating aperiodic disturbance. Two circuits, one tuned exactly to the desired frequency and the other slightly de-tuned, and a local oscillator to generate oscillations of a frequency equal to the frequency at which the slightly detuned circuit is tuned. F. Conrad, assigned to Siemens & Halske, Berlin. No. 1,874,910.

Volume control. Varying the energy transfer from an antenna to the first tube of a receiver by a variable capacity. H. A. Wheeler, assigned to Hazeltine. No. 1,873,236.

Rejecting the image frequency. In a superheterodyne receiver a pre-selector system in which a connection is made to a portion of a tuned circuit which is at node potential relative to current of the image frequencies. H. A. Wheeler, assigned to Hazeltine. No. 1,875,837.



Radio beacon system. Circuit for aircraft use. Marcel Wallace, St. George, N. Y. Filed May 6, 1930. No. 1,878,737.

Superheterodyne operation. Method of operating a superheterodyne receiver to receive any one of the number of stations equally spaced in the frequency spectrum comprising the choice of an intermediate frequency substantially equal to an odd multiple of one-quarter the frequency separation of the successive stations in the spectrum, whereby the image frequency falls midway between two undesired station frequencies when the desired one of said stations is being received. H. A. Wheeler, assigned to Hazeltine Corp. Filed February 24, 1931. No. 1,878,614.

High frequency circuit. A master oscillator power amplifier circuit using four-element tubes, one of the electrodes in the master oscillator coupled to a point in the resonant coupling circuit for compensating for reactionary effects developed by changing the resonant condition in the output of the power amplifier. A. H. Taylor, assigned to Wired Radio, Inc. Filed March 16, 1931. No. 1,878,252.

Anti-regenerative circuits. A Wheatstone bridge amplifying system whose output is tuned to a harmonic of the input frequency and arranged so that no current of output frequency is fed back to the input. Earnest Green, assigned to R. C. A. Filed February 15, 1929. No. 1,878,309.

High frequency oscillator. Method of generating ultra high frequencies in which the time of oscillation is dependent upon the time of electron transit. H. E. Hollmann, assigned to A. T. & T. Co. Filed June 20, 1929. No. 1,877,872.

Detection, Amplification, Etc.

Rectifier circuit. A circuit for rectifying alternating current to direct current comprising a transformer, an electrolytic rectifier comprising one lead and two tantalum electrodes immersed in a sulphuric acid electrolyte. C. C. Bradbury, assigned to Fansteel Products Co. Filed April 29, 1927. No. 1,878,101.

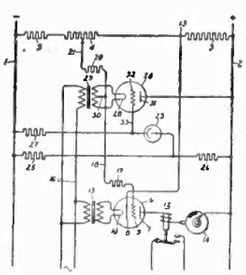
Push-pull amplifiers. A series of patents, Nos. 1,878,740 to 1,878,742, inclusive, to H. A. Wheeler, assigned to Hazeltine Corp. Filed July 16 and August 17, 1929.

Volume control circuits. A series of patents to H. A. Wheeler, Nos. 1,879,861 to No. 1,879,863, inclusive, assigned to Hazeltine Corp. Filed July 17, 1927.

Sound recording apparatus. A method of using polarized light and an electrostatic field. Delmar A. Whitson, assigned to Whitson Photophone Corp. No. 1,861,039.

Timing device. A method of interrupting a circuit for a given time interval. L. J. LeVan and Carroll Stansbury, assigned to Cutler-Hammer, Inc., No. 1,867,225.

Power control circuit. Vapor electric tubes operated from a d.c. source, and means for supplying to the grid positive and negative potentials. W. D. Cockrell, assigned to G. E. Co., No. 1,867,398.



D. C. supply system. A method of supplying d.c. to a load from an a.c. source by means of rectifying space-current devices. Jos. Slepian, Westinghouse E. & M. Co., No. 1,866,679.

Electronics Applications

Gas purifying plants. Method of using rectifier tubes discharging into a condenser shunted by a resistance. Robert Strigel, Berlin-Carlottenburg, Germany. No. 1,874,024. Filed August 5, 1929.

Watt-hour meter testing device. Method using light sensitive means, amplifier tubes, etc. Samuel Aronoff, assigned to Westinghouse E. & M. Co. Filed April 3, 1929. No. 1,878,658.

Train control. An amplifier tube becoming an oscillator under suitable circuit conditions for controlling relays and train control. T. W. Varley and W. C. Nein, New York, N. Y. Filed January 19, 1928. No. 1,878,735.

Moisture content determination. Method of using a vacuum tube oscillator and rectifier for indicating quality of a material with respect to its moisture content. J. D. Clark, Kensington, England. Filed April 22, 1927. No. 1,878,109.

Patent Suits

1,558,437, I. Langmuir, Electrical discharge apparatus, D. C., S. D. N. Y., Doc. E 47/2, Radio Corp. of America et al. v. H. Chirelstein (Sonatron Tube Co.). Dismissed for lack of prosecution (notice June 23, 1932).

1,231,764, F. Lowenstein, Telephone relay; 1,456,528, H. D. Arnold, Electric discharge device; 1,459,412, A. M. Nicolson, Thermionic translating device, D. C., S. D. N. Y., Doc. E 47/3, Radio Corp. of America et al. v. H. Chirelstein (Sonatron Tube Co.). Dismissed for lack of prosecution (notice June 23, 1932).

1,173,079, E. F. Alexanderson, Selective tuning system; 1,334,118, C. W. Rice, System for amplification of small currents; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials, D. C., S. D. N. Y., Doc. E 46/143, Radio Corp. of America et al. v. Colonial Radio Corp. Dismissed for lack of prosecution (notice June 23, 1932).

1,537,708 (a), W. Schottky, Thermionic vacuum tube, D. C., S. D. N. Y., Doc. E 47/4, Radio Corp. of America v. H. Chirelstein (Sonatron Tube Co.). Dismissed for lack of prosecution (notice June 23, 1932).

1,537,708 (b), W. Schottky, Thermionic vacuum tube; 1,558,437, I. Langmuir, Electrical discharge apparatus; 1,696,-103, G. Seibt, Electric discharge tube, D. C., S. D. N. Y., Doc. E 51/238, Radio Corp. of America et al. v. Radio Jobbers, Inc. Dismissed for lack of prosecution (notice June 23, 1932).

1,650,353, L. A. Hazeltine, Wave signaling system; 1,605,411, C. O. Weber, Non-oscillating radio frequency selective amplifier, D. C., S. D. N. Y., Doc. E 44/136, Hazeltine Corp. v. Electric Service Engineering Corp. Consent decree for plaintiff Aug. 1, 1932.

1,682,874, F. K. Vreeland, Radio frequency amplifier; 1,725,433, same, Band receiving system; 1,730,987, same, Variable band amplifier; 1,749,930, same, Variable circuit element for radio receiving sets; 1,850,973, same, Band receiving system, filed Aug. 8, 1932, D. C., S. D. N. Y., Doc. E 70/228, Vreeland Corp. v. The Aeolian Co. et al.

1,050,441, R. A. Fessenden, Electric signaling apparatus; 1,050,728, same, Method of signaling; 1,113,149, E. H. Armstrong, Wireless receiving system, D. C., S. D. N. Y., Doc. E 32/126, Westinghouse Electric & Mfg. Co., et al. v. Kosdon Products Co., Inc. Dismissed for lack of prosecution (notice June 22, 1932).

1,203,190, Fritts & Fritts, Recording and reproduction of pulsations or variations in sounds and other phenomena; 1,213,614, same, Record of pulsations of sound and analogous phenomena and process and apparatus for producing same; 1,223,496, I. Langmuir, Electrostatic telephone system; 1,297,188, 1,313,-094, same, System of amplifying variable currents; 1,840,351, W. L. Douden, Sound record and method of producing same, filed Apr. 18, 1932, D. C., S. D. N. Y., Doc. E 66/382, R. C. A. Photophone, Inc., et al v. Bene Seal Sound Devices, Inc.

1,231,764, F. Lowenstein, Telephone relay; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier D. C., S. D. Calif. (Los Angeles), Doc. T-76-H, Radio Corp. of America et al. v. May Department Stores Co. Dismissed for want of prosecution Apr. 6, 1932.

Re. 14,816, W. Tschudy, Method for controlling the efficiency of mercury rectifiers; 1,666,516, same, Vapor rectifier, filed Apr. 7, 1932, D. C., S. D. Calif. (Los Angeles), Doc. 5499-C, W. Tschudy v. Westinghouse Electric & Mfg. Co. Doc. 5500-C, W. Tschudy v. Allis-Chalmers Mfg. Co.

1,533,858, L. A. Hazeltine, Method and means for neutralizing capacity coupling in audions, D. C., S. D. N. Y., Doc. E 54/122, Hazeltine Corp. v. General Motors Radio Corp. et al. Consent decree for plaintiff (notice May 4, 1932).

1,710,073, 1,714,191, S. Ruben, Electrical condenser, filed May 18, 1932, D. C., S. D. N. Y. Doc. E 6342, Ruben Condenser Co. et al. v. E. N. Tooker et al.

1,231,764, F. Lowenstein, Telephone relay; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier; 1,403,932, R. H. Wilson, Electron discharge device, D. C., S. D. N. Y., Doc. E 60/175, Radio Corp. of America, et al. v. F. W. Lang (Lang Radio Co.). Consent decree for plaintiff (notice Mar. 16, 1932). (To correct error in 409 O. G., p. 566 and 418 O. G., p. 556. Patent 1,465,332 originally reported as 1,465,932, E. H. Colpitts, Multiplex radiotelegraph system).

1,533,858, L. A. Hazeltine, Method and means for neutralizing capacity coupling in audions, appeal filed Mar. 28, 1932, C. C. A., 2d. Cir., Doc.—, Hazeltine Corp. v. Radio Corp. of America.

1,141,402 (a), R. D. Mershon, Electrolytic apparatus employing filmed electrodes, filed Mar. 29, 1932, D. C., E. D. N. Y., Doc. E 6173, R. D. Mershon v. M. Pickon et al.

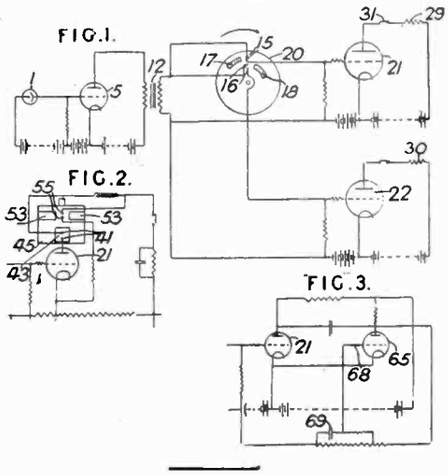
1,141,402 (b), R. D. Mershon, Electrolytic apparatus employing filmed electrodes; 1,784,674, same, Film formation and operation of electrolytic condensers, etc., filed Mar. 30, 1932, D. C. Mass., Doc. E 3608, R. D. Mershon et al. v. Sprague Specialties Co.

BRITISH PATENTS
IN THE FIELD OF ELECTRONICS

Radio Circuits

Generating and amplifying high-frequency oscillations. A material such as galena, which in contact with an iron wire has a negative resistance characteristic, is reduced to fine powder and placed between electrodes, the pressure of which is adjusted so as to produce a negative resistance characteristic by the loose contact between the individual grains. The size of the granules is determined experimentally, and is stated to be below 0.1 mm. The pressure of the electrodes necessary is stated to vary directly with the volume of the substance. As an example, with a column of 1 sq. mm. in area and 1 cm. long, the pressure should be in the neighborhood of 300 gm. per sq. cm. A mixture of lead sulphide with a small proportion of copper sulphide is fused or sintered as disclosed in Specification 360,920, and then powdered. Metals, such as iron or molybdenum, which give a negative resistance characteristic in contact with the substance used, may be added. About one-third of its volume of a neutral powder of the same chemical nature, such as antimony trisulphide, is then added and the mixture ground up and pressed firmly between two electrodes. The pressure in this case may be about ten times that required when the neutral powder is absent. The resistance powder may be immersed in a non-conducting liquid such as oil, benzol, etc. This liquid or the surrounding gas is preferably subjected to a pressure higher than atmospheric. The resistance may be cooled by embedding a number of metal discs in the mass so as to project at their edges as cooling ribs, which may dip into oil. Resistances made in accordance with the invention are applicable for the generation and amplification of electric oscillations, and may be employed as repeaters in telephone lines. Habann, E., 44 Stargarderstrasse, Berlin. No. 367,790.

Printing press control. Apparatus comprising light sensitive cells for automatically controlling the range of speeds of an inset web in relation to the other webs fed from a printing press or other machine. British Thomson-Houston Co. No. 373,189.



Superheterodyne receiver. Means are provided for de-tuning two circuits operating at a super-audible frequency in opposite directions to control the over-all selectivity without altering the mid-frequency of the band of frequencies selected by the receiver as a whole. A. N. Goldsmith, Marconi Co. No. 373,543.

Permeability tuning system. A wireless receiver giving constant amplification over the whole tuning range, is characterized by the use of tuning inductances made with a core of very finely powdered iron, produced for instance, by reducing iron sulphate by the action of hydrogen. The iron particles should pass through a machine of 250-300 mesh to the inch. The iron powder may be mixed with wax, paraffin, mineral oil, rubber, gum or varnish, impressed or molded into shape. In such coils mutual inductance is greatly increased, affording a very tight coupling. The core or a piece of the winding may be movable. W. K. Polydoroff, Johnson Laboratories, Inc. No. 366,475.

Television system. Ultra-short waves are rectified at a central station and the resulting picture signals conducted along wires to several receivers. The internal resistance of the rectifier is small, to avoid reaction. A common aperiodic amplifier is connected to the rectifier by a shielded line. M. Von Ardenne, Berlin, Germany. No. 366,856.

Radio alarm. An alarm device suitable for use on ships during fog, comprises a small c.w. transmitter, a receiver for actuating a warning device, automatic means for actuating each in succession in a predetermined way and means to enable the transmitter and receiver to be used for telephone communication. Marconi Co. No. 372,750.

Program distribution. A system for redistributing broadcast programs either as high frequency or low frequency current, suitable for use on railway trains or other moving vehicles, characterized by the use of two or more aerials located at different points on the moving train, etc., so as to insure a constant level of signal strength irrespective of fluctuations in pick-up due to any directional shielding or similar effects caused by the movement of the train. C. C. Shumard, Marconi Co. No. 372,834.

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British Patent Reforms

By a Special Correspondent

On November 1st, 1932 a new Act is scheduled to bring into operation various important changes in British patent procedure. The most notable is an enlargement of the official search—which up to the present has been limited to prior British patents over a period of 50 years—so as to embrace American and other patents, together with all relevant text-books and technical publications. In this respect British practice is only now being brought into line with American procedure.

Prior publication of the invention in a patent specification appertaining to any country outside Great Britain is made a definite ground for opposition, as well as for the revocation of an existing patent. Among other specified grounds for revocation are: (a) that the invention is not useful; (b) that the scope of the monopoly claimed is not clear; (c) that the specification does not fairly describe and ascertain the nature of the invention; (d) that the invention is obvious and does not involve any inventive step; (e) that the specification does not describe the best method of carrying out the invention known to the inventor when he filed his application.

Power is given the Comptroller of the Patent Office to refuse a grant for an invention which (a) has been wholly described in a previous publication or (b) is so obviously contrary to established scientific principles as to be frivolous.

The margin of time for filing a complete specification after a provisional specification, is extended from nine months to a year, whilst the normal period for acceptance is now 18 months instead of 15. Sealing may take place up to 21 months after filing.

One effect of these longer time allowances will be to delay by a corresponding period the publication of accepted British patents. This is a point of considerable importance in a "live" industry such as radio.

The time at which a Foreign application, made under the International Convention, falls open to public inspection is increased from 12 to 18 months from the date of priority claimed in the Foreign country. Another new provision affecting convention cases allows two related applications made within a period of 12 months to be cognated into a single British patent.

The official fees are slightly increased. The actual incidence falls on the complete specification, the filing fee for which is increased from £3 to £4, raising the total charge, up to and including Sealing, from £5 to £6.

The law is strengthened to further protect the public against groundless threats on the part of patentees in respect of proceedings for infringement. Finally a special Appeal Tribunal consisting of a Judge of the High Court is created for the purpose of hearing and deciding disputes arising between the Patent Office and the inventor.

Shrinkage control in radio tube manufacture

[*Continued from page 333*]

in the office and at five o'clock a meeting is held at which all engineers and foremen participate.

Shrinkage reasons of the day are discussed and wherever possible immediate steps are taken to eliminate certain reasons. The results have been astonishing. Defects in stems, in small parts, shorts due to careless basing or bad mounting, low emission, gassy tubes, "no reading," defects in heaters, etc., are traced right back to the real source responsible. If the wrong party is blamed or the real reason for shrinkage is questionable, the rejected tube is opened before everybody. Foremen have a chance to tell of their troubles with machines or tools, suggestions are forthcoming and immediately discussed and general interest is aroused.

5. Everybody has been reduced in salary due to the present conditions, but everybody has an enormous interest in increasing his earning capacity. The chances for the men in the tube industry are small; their interest vanishes completely with the question: how long will the firm exist? Here is the place where the industrial engineer can step in and help to keep up the spirit. Responsible for highest efficiency in the plant, he assumes also leadership for its future existence and instead of becoming a sworn enemy of many employees, he turns out to be their best friend. He knows the figures, he knows that shrinkage costs per month amount to more than savings effected through salary cuts. His figures show clearly that savings in shrinkage can be made.

To turn the interest in shrinkage to good account a shrinkage bonus system can be installed. A certain allowance of shrinkage for each type of tube can be fixed and applied to the prime cost estimates. If that shrinkage decreases below the allowance, a saving is made. If now 30 per cent of those savings effected are distributed at the end of the month among the engineers and foremen, a spontaneous interest will arise, the daily meetings are seen to be not an unnecessary loss of time, but something of general interest.

6. Returns are often neglected. An immediate analysis of returns will tell much. Damaged goods can be traced back to poor packing or bad shipping conditions, complaints about defective readings, etc., can be the result of the customer's own testboard which needed a checkup. In other words, returns are to be treated like shrinkage. They need analysis and close study, and must be brought down to a minimum.

7. A monthly inventory must be the basis for correct production during the following month. Purchasing, scheduling, planning of labor increases, control of costs are largely dependable on the correct knowledge of the question *what do we have on hand?* With flexible raw material prices and sales values, losses are possible, and any loss means less resistance to competition.

Too often executives say they cannot afford or do not need an industrial engineer in the radio tube industry, but rather that sacrifices have to be made. But they rarely see the sacrifices that must be made in too large administration and sales expenses, in excessive shipping costs, in leniency toward indirect labor and high piecework rates. They forget it is enormously important to watch the shrinkage and the spirit of the employees.

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The ribbon microphone and its applications

[*Continued from page 337*]

microphone (such as the condenser microphone). For a given permissible amount of recorded reverberation, the ribbon microphone may be used at 1.7 times the distance (from an actor) of a non-directional microphone. This is a great advantage in sound picture work, where it is necessary to keep the microphone "out of the picture."

New microphone aids studio arrangement

In broadcasting, a variety of new set-ups of artists and orchestras become possible. Two of these are illustrated in the figure. In one case, a singer is placed on one side of the microphone and the conductor and orchestra on the other side. The relative distances of singer and orchestra from the microphone can thus be varied at will, and the singer, conductor and orchestra can observe each other. This facilitates response to cues and changes of tempo. In a second case, two actors are shown facing each other across the microphone, a set-up which may assist in the production of realistic dialogue.

An interesting application to public address systems is shown. It is well known that with ordinary non-directional microphones it is necessary to place the loudspeakers ahead of the microphones or otherwise acoustic feedback will result. Often this is difficult because of absence of suitable supports, for example, in outdoor parks. With the ribbon microphone the loudspeakers may be placed so that the sound from them actually travels directly across the microphone position if the ribbon is turned as shown in the figure. Under these conditions, no acoustic feedback has been found to result.

A final illustration shows a novel use of the ribbon microphone in acoustical measurements. Loudspeaker characteristics are best taken out-of-doors, with the loudspeaker raised 10 or 15 feet above the ground. When this is done, the sound output measured by a microphone some distance away consists of the sum of the direct sound from the loudspeaker and the sound reflected from the ground. With the ribbon microphone oriented as shown, the response due to the reflected sound is eliminated and only the direct sound is measured. This results in a materially smoother frequency characteristic than those ordinarily obtained with non-directional microphones.

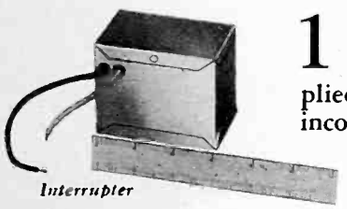
EDITOR'S NOTE—Interesting data on the response of the ribbon or velocity microphone are contained in an article by Dr. H. F. Olson in *Broadcast News*, October, 1932, published by RCA Victor Company and edited by E. Jay Quinby. When used with a suitable transformer to couple to a 250-ohm line, the output is practically flat between 30 and 10,000 cycles at a level of about —31 decibels.

ELECTRONIC ANNOUNCES *FULL WAVE*

POWER SUPPLY FOR AUTOMOBILE RADIOS

Of outstanding importance to the radio industry and to radio engineers is the development by Electronic Laboratories, Inc., of Indianapolis of a new full wave power supply for 1933 automobile radios. Compact, efficient and low in price, this new "B" battery eliminator contains many important features of design, some of them exclusive and all of them not embodied in any other unit. Electronic power supplies can be obtained with efficiencies varying from 50 to 60 per cent, depending on the type design. All have the exclusive use of the automatic load delay circuit, explained below. These units are manufactured for every requirement.

Nine Outstanding Features



Interrupter

1 *Full Wave Interrupter*—A complete interrupter in one assembly may be supplied to the manufacturer to incorporate in his set. The entire unit is inserted in a cadmium plated steel container lined with live sponge rubber to eliminate all radio frequency interference and mechanical noise. The overall dimensions of the complete interrupter assembly are only $1\frac{7}{8}$ x $2\frac{5}{8}$ x $3\frac{1}{8}$ inches.

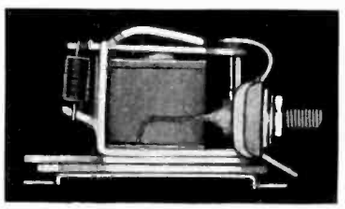
2 *Full Wave Rectification with Mercury Vapor Rectifier*—This assures an even flow of current and freedom from radio frequency interference. A newly developed tube of the cathode type having mercury vapor content is used.

3 *More Than 80 Per Cent Regulation*—The regulation of the new Electronic power supply is exceedingly high as a result of the full wave rectification and the low drop in the mercury vapor rectifier.

4 *More than 50 Per Cent Efficiency*—An efficiency of well over 50 per cent is guaranteed because of the new design of the power supply circuit.

5 *Completely Automatic*—It is not necessary to tap in the radio set to reach a hot wire. The hot set lead goes directly to the eliminator.

6 *New Automatic Load Delay Circuit* — This circuit completely protects the interrupter, the rectifier tube, the filter system and all integral parts of the power supply. It delays the application of voltage to the radio set until tubes have reached normal temperature, thus protecting the set from high voltage surges. Moreover, it gives higher efficiency by permitting the safe use of a mercury vapor rectifier tube. This circuit is of great merit in A. C. domestic radios using type 82 or type 83 tubes.



Load Delay Relay

7 *No Polarity to Respect*—The Electronic Eliminator may be connected with either polarity due to the full wave interruption.

8 *Adjustable Intermediate Voltage Tap*—Incorporated in the assembly of this new unit is a high quality variable voltage divider so that any voltage may be obtained by merely turning a screw.

9 *Noiseless in Operation*—Use of the Electronic Eliminator assures continuous, silent operation both mechanically and electrically.

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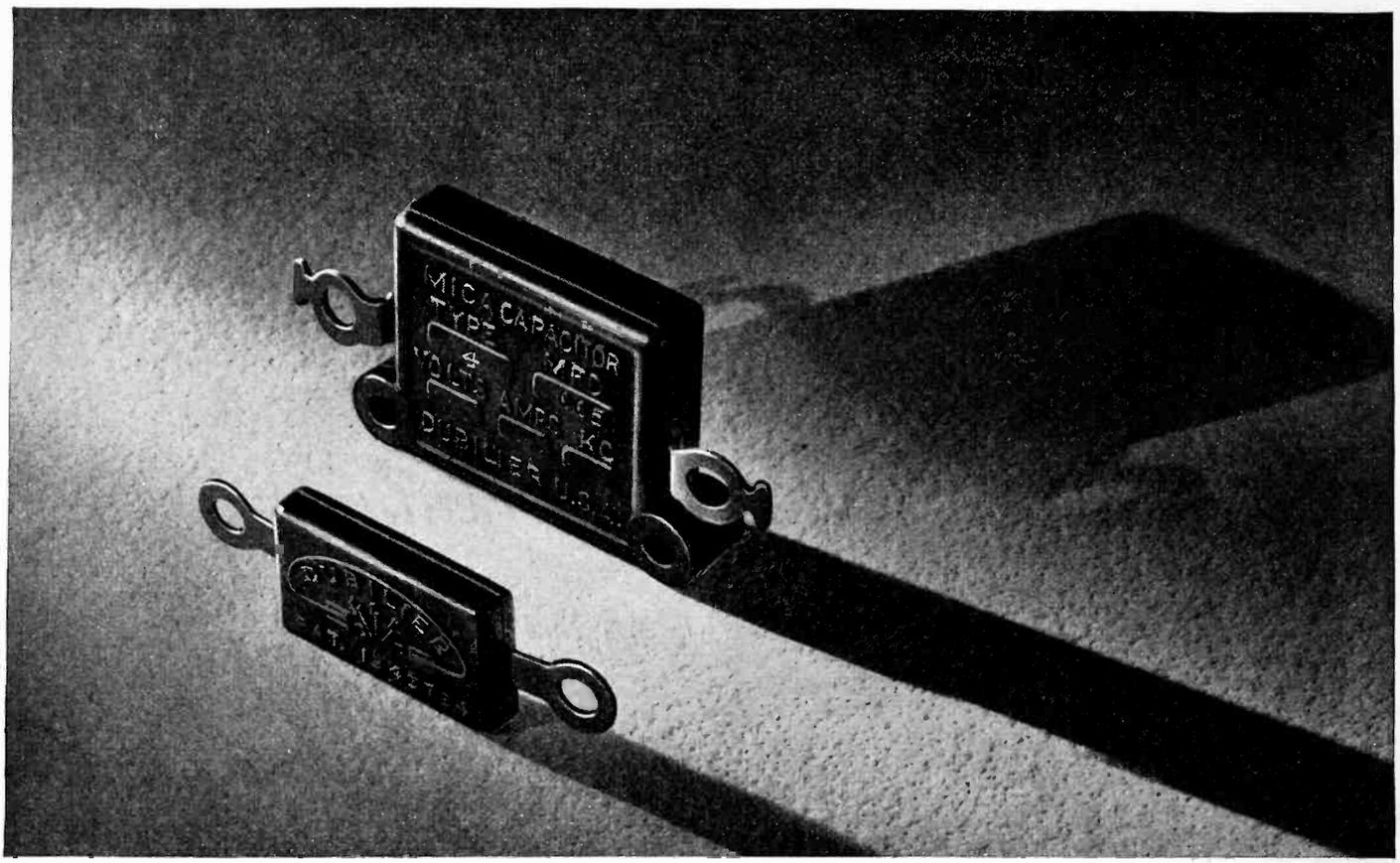
122 West New York St. Indianapolis, Ind.

Exposure cannot harm *sensitive elements sealed within Bakelite Molded*



Bakelite Molded capacitors made by Dubilier Condenser Corp., New York, N.Y.

TO OPERATE successfully, a capacitor must be so constructed that even the slightest dampness is excluded from the electrical element. Through years of experience Dubilier has found that the most practical and dependable way to assure the exclusion of moisture is to seal the element within a Bakelite Molded shell.

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Development of electronic equipment and devices requiring electrical insulation immune to deterioration, is being materially aided by the use of Bakelite Molded. Our engineers and laboratories are always at the service of manufacturers in adapting Bakelite Materials to their particular needs. We also have an interesting booklet, "Bakelite Molded", and will mail a copy promptly on request. Ask for booklet 13M.

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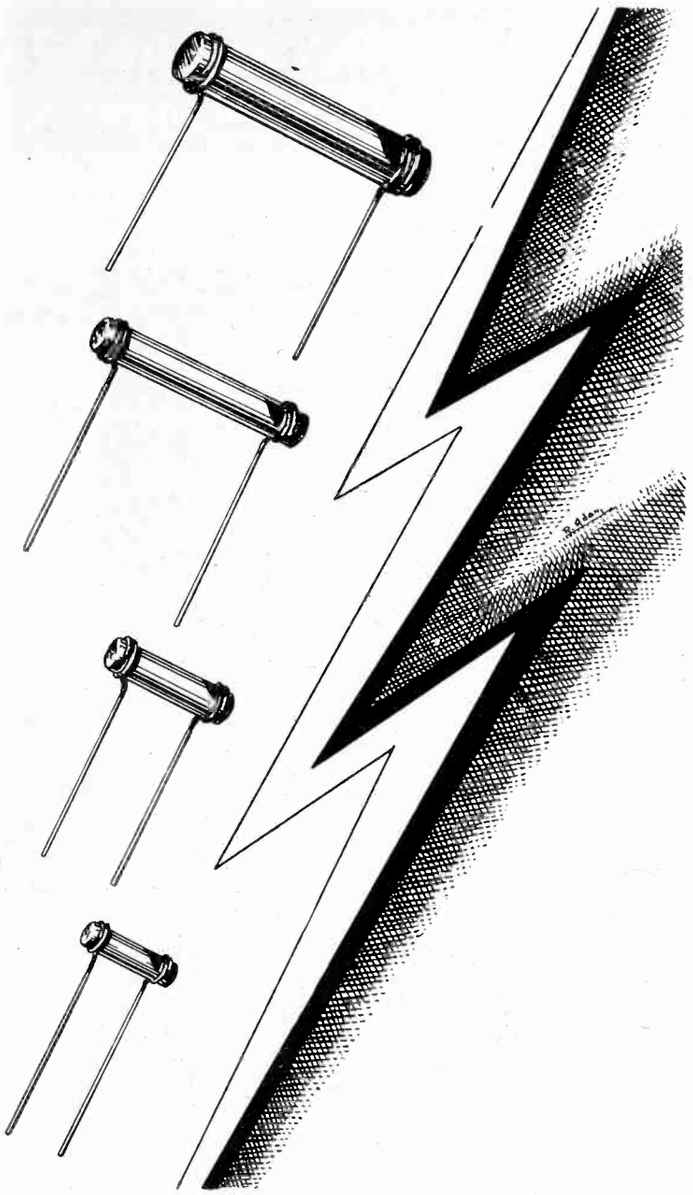


The change of resistance with voltage is very small in Erie Resistors, being less than 2% in the majority of cases, so that it is not necessary to specify the testing voltage except where special precision is necessary.

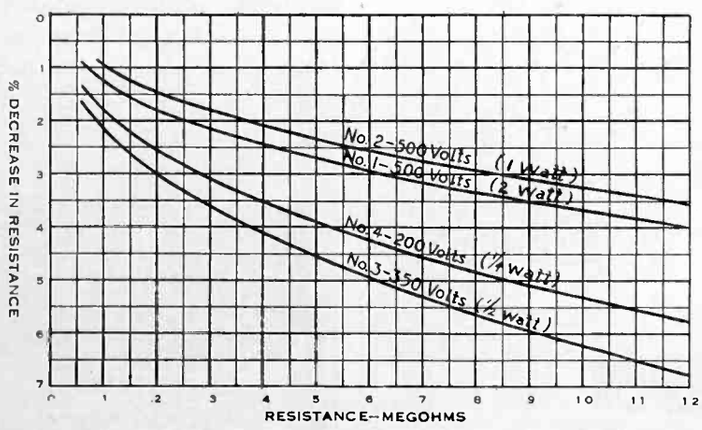
This allows an appreciable saving to set manufacturers since only one size need be carried in stock where the same resistance value is to be used on different voltages.

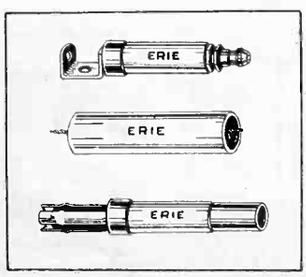
The accompanying curve shows the percentage decrease in resistance for the maximum voltage change. For smaller voltage changes the resistance change will be proportionally smaller.

Consider, for instance, a No. 4 (1/4 watt) resistor which measures 1/2 megohm at 100 volts. If this resistor is to be used at 150 volts the resistance will be less than 1/2 megohm because the voltage is 50 volts higher. The curve shows 3.9% change for 200 volts change on a No. 4 1/2 megohm resistor, so the resistance change will be less than 1% $\left(\frac{50}{200} \times 3.9\right)$ when the voltage is changed from 100 volts to 150 volts. If this resistor were to be used as a grid leak with no voltage drop across it, it would measure higher by less than 2% $\left(\frac{100}{200} \times 3.9\right)$ higher than 1/2 megohm at this low voltage.

A 1 Megohm No. 2 (1 watt) resistor changes 3 1/4% with 500 volts change. If the working voltage differs by 200 volts from that at which the resistor is measured, the resistance will be 1.3% $\left(\frac{200}{500} \times 3\frac{1}{4}\right)$ different from the measured value.

VOLTAGE EFFECT





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Factories in Erie, Pa., Toronto, Canada, and London, Eng.

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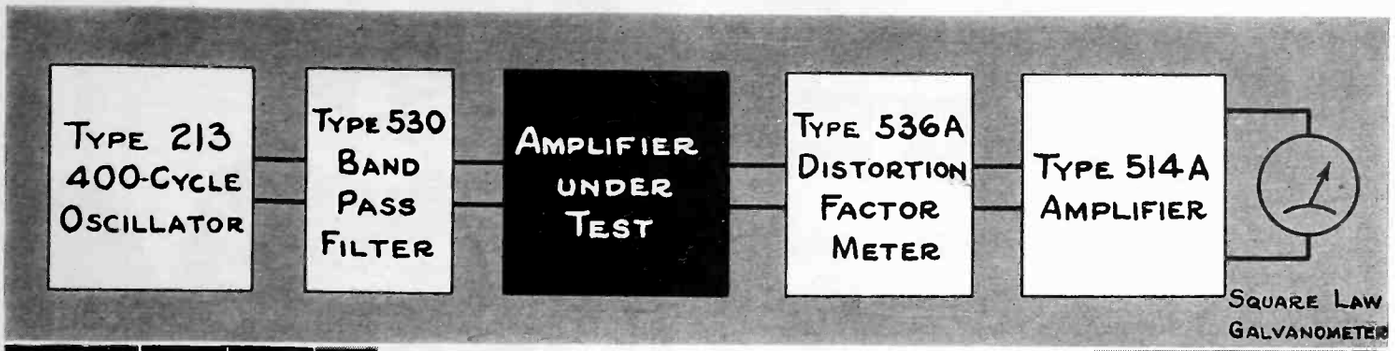
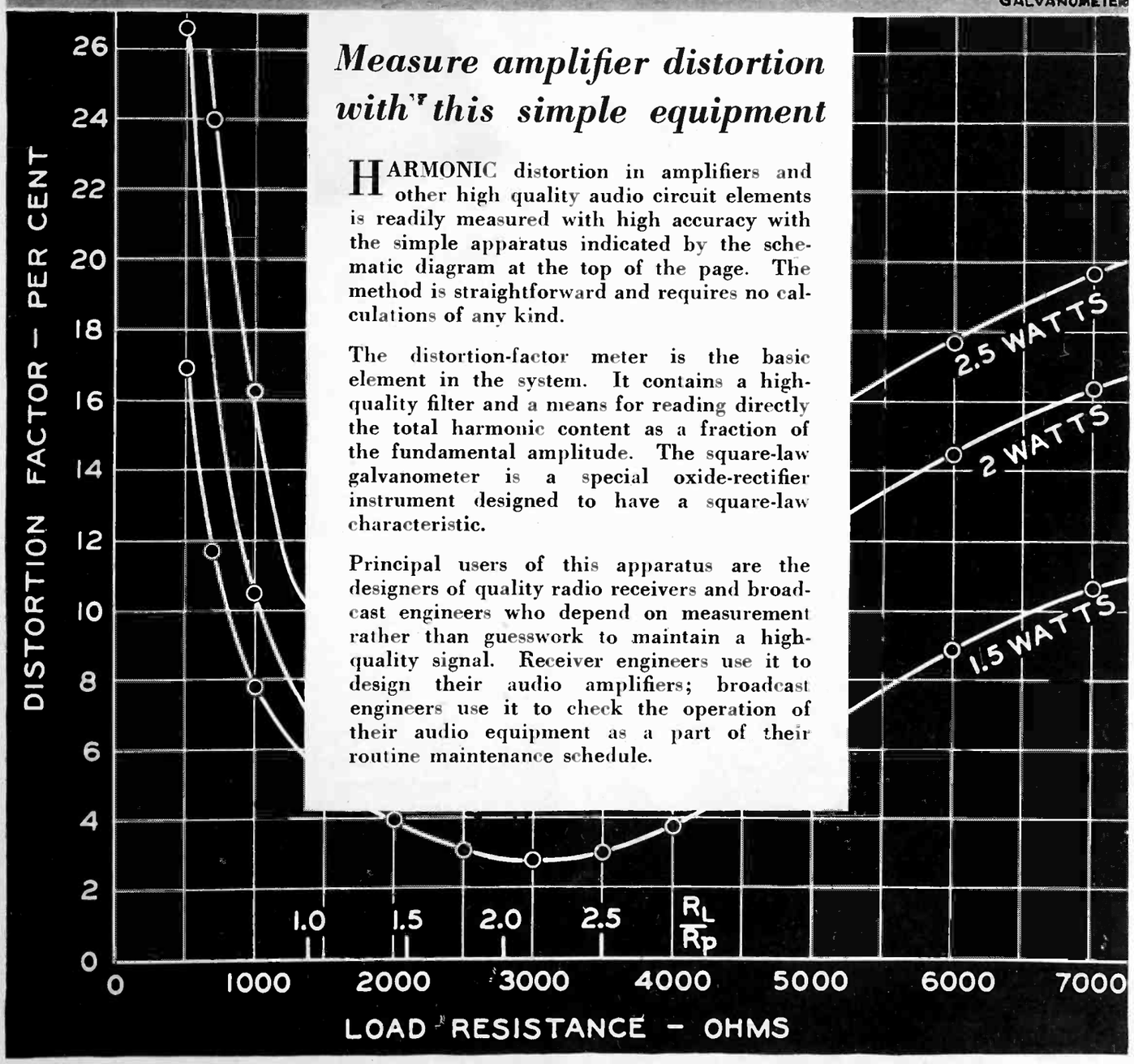
The resistance unit is enclosed in a ceramic tube to protec it from mechanical breakage as well as from oil, dirt and moisture.





Measure amplifier distortion with this simple equipment

HARMONIC distortion in amplifiers and other high quality audio circuit elements is readily measured with high accuracy with the simple apparatus indicated by the schematic diagram at the top of the page. The method is straightforward and requires no calculations of any kind.

The distortion-factor meter is the basic element in the system. It contains a high-quality filter and a means for reading directly the total harmonic content as a fraction of the fundamental amplitude. The square-law galvanometer is a special oxide-rectifier instrument designed to have a square-law characteristic.

Principal users of this apparatus are the designers of quality radio receivers and broadcast engineers who depend on measurement rather than guesswork to maintain a high-quality signal. Receiver engineers use it to design their audio amplifiers; broadcast engineers use it to check the operation of their audio equipment as a part of their routine maintenance schedule.

The price of the complete equipment is $324.50. Write for descriptive literature and details of its application to your distortion-measuring problems. Address General Radio Company, Cambridge, Massachusetts.

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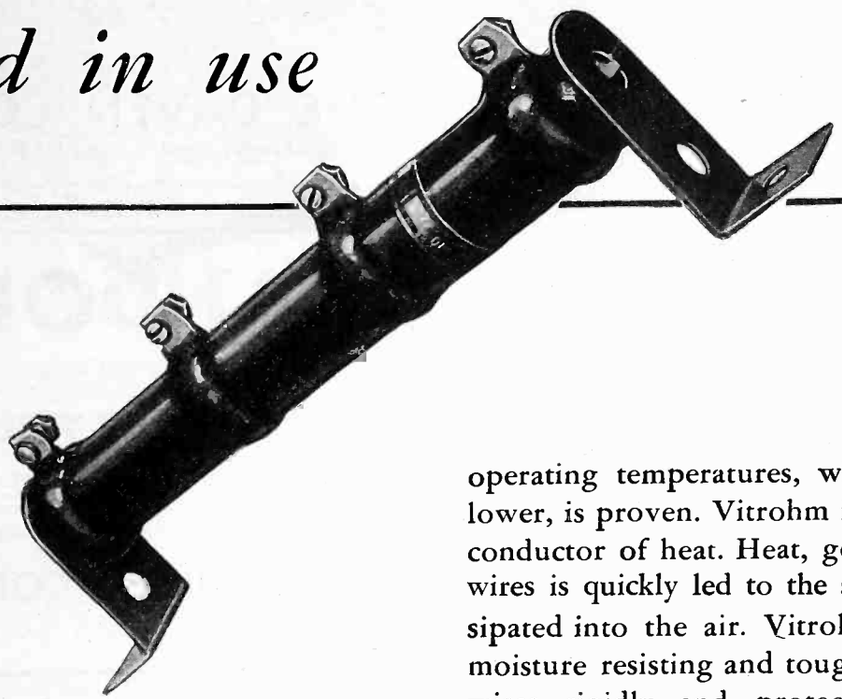
Higher temperatures are employed in manufacture . . . . *than are ever reached in use*



THE very nature of Vitrohm (vitreous enamel) necessitates that the tubes and wires be baked at temperatures high enough to make *the glass flow.* Therefore, while the enamel is being processed, the wires are normalized. Internal stress or stresses from bending are thus relieved and the ability of the wire to withstand the operating temperatures, which are much lower, is proven. Vitrohm is a remarkable conductor of heat. Heat, generated in the wires is quickly led to the surface and dissipated into the air. Vitrohm is acid and moisture resisting and tough. It holds the wires rigidly and protects them from oxidation or mechanical damage.

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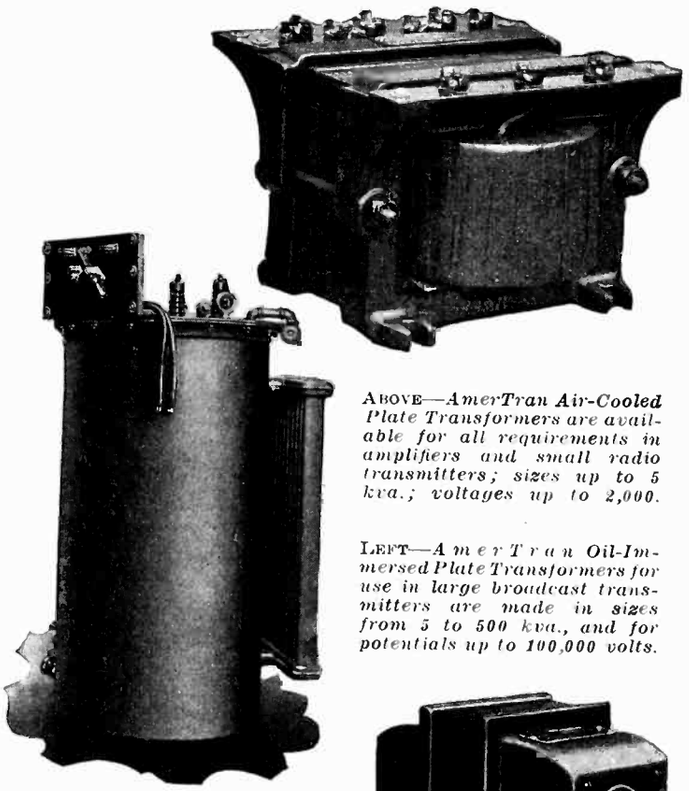
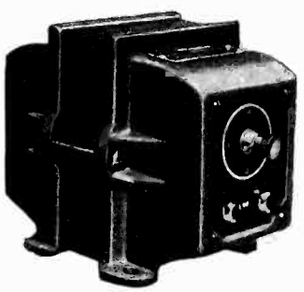


ABOVE—*AmerTran Air-Cooled Plate Transformers are available for all requirements in amplifiers and small radio transmitters; sizes up to 5 kva.; voltages up to 2,000.*

LEFT—*AmerTran Oil-Immersed Plate Transformers for use in large broadcast transmitters are made in sizes from 5 to 500 kva., and for potentials up to 100,000 volts.*



RIGHT—*AmerTran Power Transformers for radio sets and amplifiers supply plate and filament voltages. Stock sizes for all standard tubes.*

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Of Electronics, published monthly at New York, N. Y., for Oct. 1, 1932.

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

Before me, a Notary Public in and for the State and county aforesaid, personally appeared C. H. Thompson, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, Inc., publishers of Electronics, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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C. H. THOMPSON, Secretary.

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[SEAL] H. E. BEIRNE,
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(My Commission expires March 30, 1933)

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CONTENTS *for* NOVEMBER, 1932

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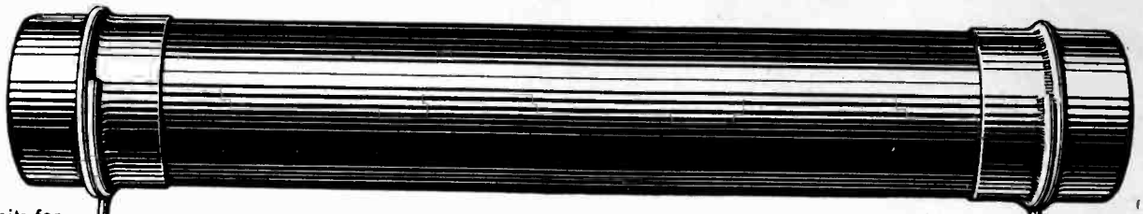
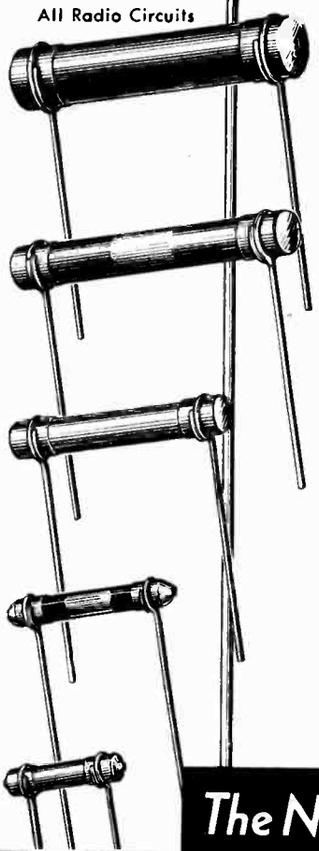


Bradleyunits for All Radio Circuits



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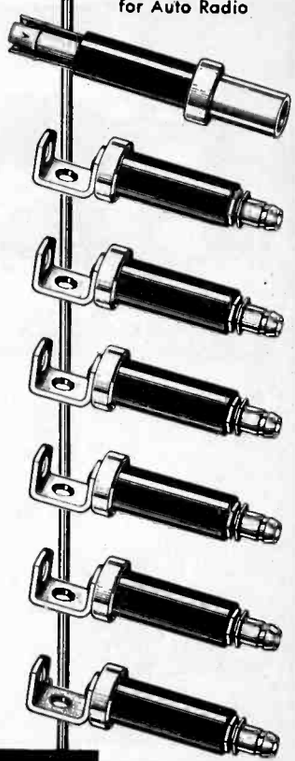

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Solid Molded Resistors

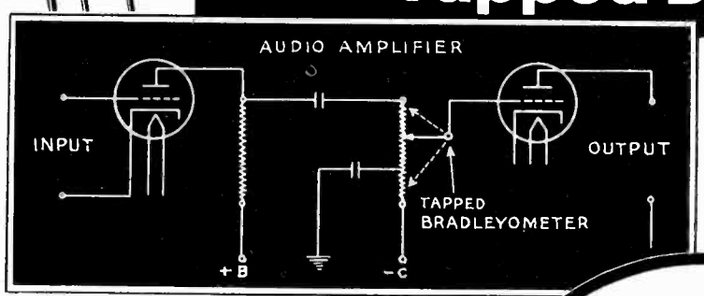
The Choice of the World's Largest Radio Manufacturers

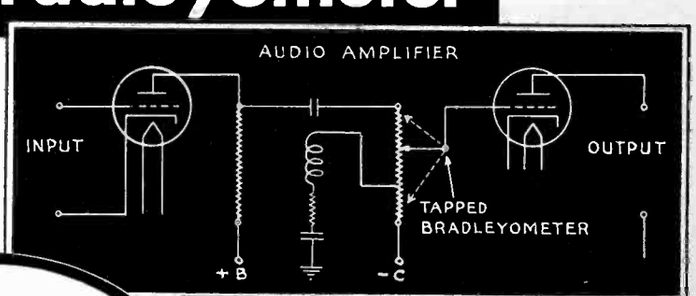
Don't risk the reputation of your receiver with poor resistors. Standardize on Bradleyunit Resistors because their resistance values are stable under varying conditions of load, temperature and moisture.

Bradleyunit Resistors are made in five sizes, with or without leads, and are R.M.A. color coded for resistance value identification. These solid molded resistors are accurately calibrated and have great mechanical strength. Get an Allen-Bradley quotation on your next order.

Allen-Bradley Co. 110 W. Greenfield Avenue., Milwaukee, Wis.

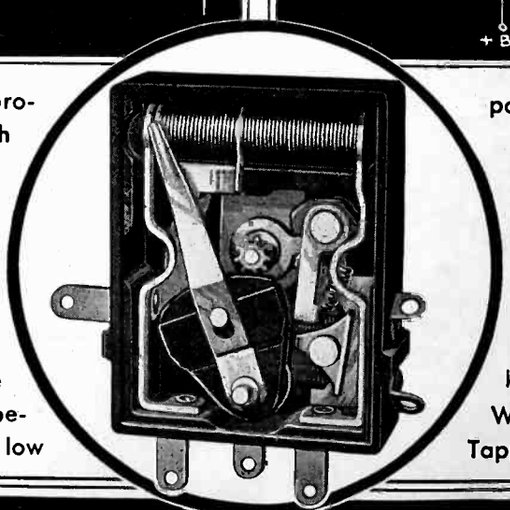
The New Tapped Bradleyometer





The new Tapped Bradleyometer provides automatic tone correction with volume control. It achieves this result in any one of several audio frequency networks. (See above diagrams.)

A tap on the resistance element is brought out to a fourth terminal. The network necessary to provide tone correction is usually connected between this tap and the grounded or low potential end of the Bradleyometer.



A single-pole line switch approved by the Underwriters' Laboratories and the Hydro Electric Power Commission of Ontario with a rating of 2 amperes, 125 volts, can be provided within the Bradleyometer and is operated by the regular control knob.

Write for complete data on the New Tapped Bradleyometer.

ALLEN-BRADLEY RESISTORS
Produced by the makers of Allen-Bradley Control Apparatus

"Why wait 'til history repeats itself?"

Ask America's leading automobile radio set manufacturers

In home radio the old set with an outside eliminator has given way to the built-in compact set everybody knows—and everybody wants. True enough, some makers of automobile radios still design their sets to take an outside eliminator or batteries—but most manufacturers who seek "a place in the sun" favor the built-in job with the Mallory-Elkonode. "Why wait", they say, "'til history repeats itself?"

And we echo their question. But—write today for our views on the trends in automobile radio—and draw your own conclusions.

P. R. MALLORY & CO., Incorporated
Indianapolis, Indiana

MALLORY
ELKON
"B" ELIMINATOR

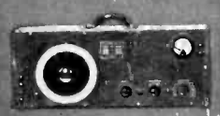
1 Cadmium plated metal outer cover of the Mallory-Elkonode.

2 Soft spongy rubber inner cover of the Mallory-Elkonode which makes it vibration-proof.

3 Mallory-Elkonode unit itself—ingenious yet simple in construction and proven in performance.

4 The tried and proven Mallory-Elkonode can be built into an all-electric set cheaper than any other power unit. The Mallory engineers are at the service of the engineers of radio set manufacturers to explain full particulars.

From "RADIO HEADQUARTERS"



Beat Frequency Oscillator TMV-28

Magnetic Pickup and Inertia Tone Arm

Type RP-67 Automatic Record-Changer
(Plays either 78 or 33⅓ RPM records)

RCA Victor Products

For Dependability

A generation of radio research and technical experience brings perfection to every product bearing the RCA Victor name.

TEST RECOMMENDATIONS OF I.R.E. AND STANDARDIZATION COMMITTEE OF RMA

can be successfully met only through the use of the proper test equipment. The RCA Victor line of production test apparatus is designed specifically for this purpose, and will insure perfection in your products before they leave your factory.

MAGNETIC PICKUPS

Either low or high impedance types, complete with new "Inertia" Tone Arms which give improved frequency response and tracking ability.

FARADON CAPACITORS

Both transmitting and receiving types are now produced at "Radio Headquarters."

ELECTRIC PHONOGRAPH ASSEMBLIES

Complete motor boards, including pickup, turntable, motor, automatic stop, etc., ready for mounting directly in your combination cabinet. Automatic record changing mechanisms are also available. Turntables for 78 or 33-1/3 r.p.m. operation.

LOUDSPEAKERS

(Either Permanent or Electro-Magnetic Fields)

The RCA Victor line of Loudspeakers has already created a reputation for faithful response over the widest volume range from minimum to maximum. Special models with permanent fields are also available for automobile and portable sets.

EQUIPMENT AND PARTS

supplied to meet your particular requirements. Specialized engineers are available to assure you of correctly designed apparatus. The wide experience and the prompt service of the greatest radio industrial center of the world is at your disposal.

Universal Visual Test Set Type TMS-36

"Faradon" Capacitors

Type RL-36 Midget Electro-Dynamic Loudspeaker

INDUSTRIAL PRODUCTS SECTION

RCA Victor Company, Inc.

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