

OCT. 18th

1930

TUNED IMPEDANCE RF!

RADIO WORLD

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The First and Only National Radio Weekly

447th Consecutive Issue—NINTH YEAR

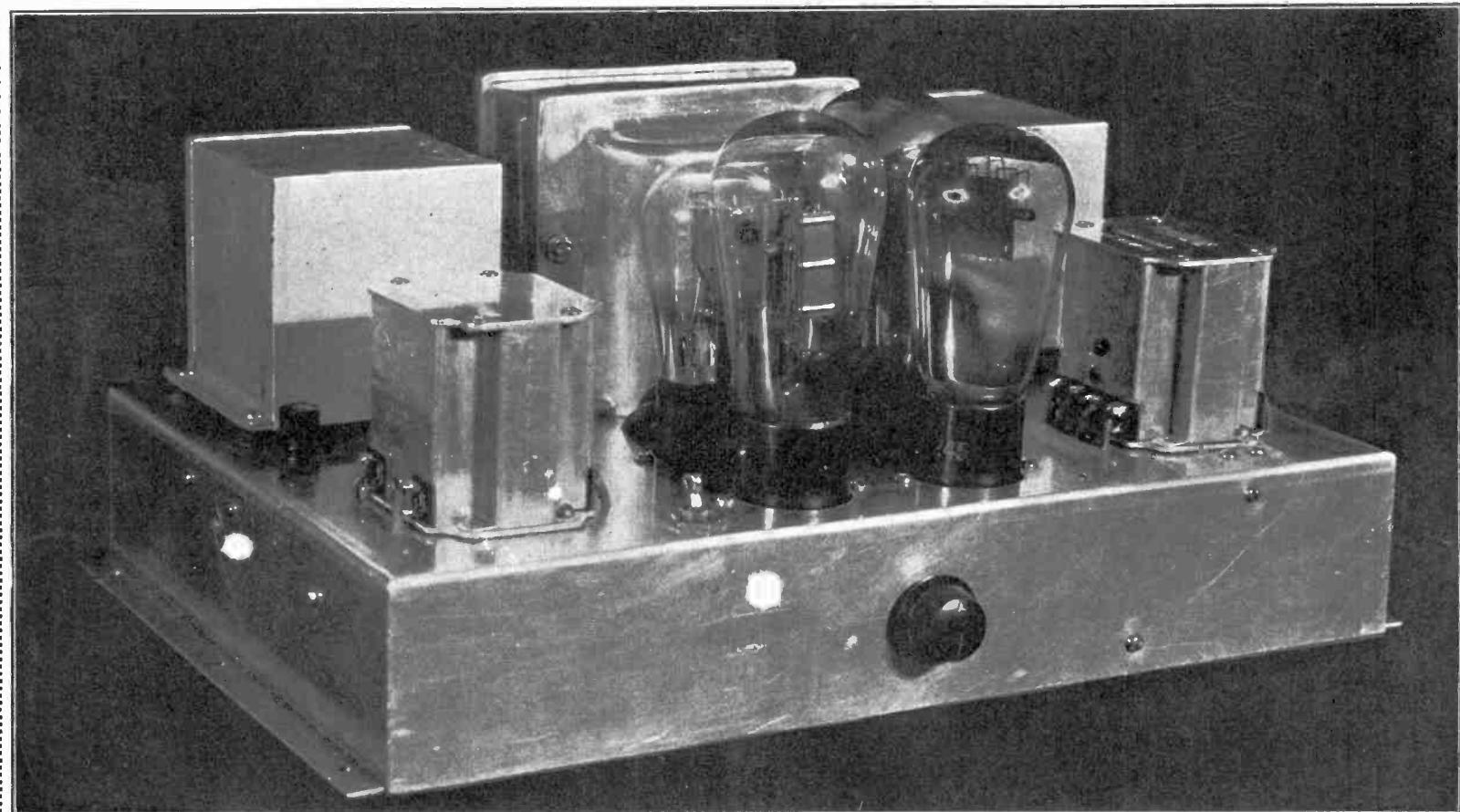
245 AND 210 ANALYZED

HERTZ'S TRANSMISSION
ON 4 AND 5 METERS

A TUBE-DRIVEN
TUNING FORK

LOFTIN-WHITE VOLTAGES

A FINE POWER AMPLIFIER!

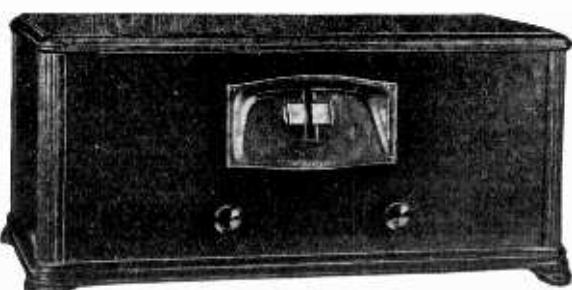


A push-pull power amplifier, with 245 output,
that affords heater and plate voltages for a
tuner as well. See article on page 10.

15c
Per
Copy

RADIO WORLD, Published by Hennessy Radio Publications Corporation; Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.

Balkite Push-Pull Receiver



The Balkite A-5 Neutrodyne, one of the most sensitive commercial receivers ever developed; 8 tubes, including 280 rectifier. Wholly AC operated, 105-120 v., 50-60 cycles; in a table model cabinet, genuine walnut, made by Balkite & Goss.

Three stages of tuned RF, neutralized, so there's no squealing; easy tuning; operation on short piece of wire indoors perfectly satisfactory; no repeat tuning points; no hum; phonograph pickup jack built in; excellent tone quality; good selectivity. Two posts are accessible for connecting the field coil of a DC dynamic speaker.

The parts of which this receiver is made are all ace-high, and the wiring is done with extreme care, by Gilfillan. The power supply is exceptionally fine, the set being worked at 50% less than the rated capacity of the power transformer and chokes, assuring long life. There is no hum, as filtration is remarkably good.

The illuminated drum dial, at center, reads 0-100 at left, and at right has a blank space in which to write call letters. The little knob at left is the volume control, and the one at right is the AC switch. Each RF stage is filtered and bypassed individually, and the RF coils, tuning condenser and power transformer are separately and totally shielded. The lead from antenna binding post to antenna winding of the first coil is of shielded wire that is grounded. Also, the receiver as a whole is totally shielded, with metal chassis and metal end cover, so there is no stray pickup. Complete with walnut magnetic speaker and tubes....

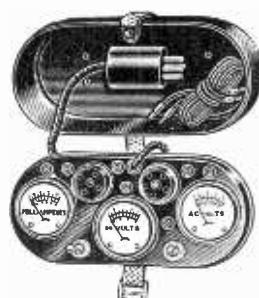
\$56.57

Silver-Plated Coils

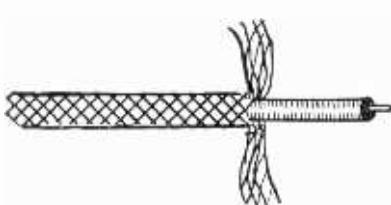


Wound with non-insulated wire plated with genuine silver, on grooved forms, these coils afford high efficiency because of the low resistance that silver has to radio frequencies. The grooves in the moulded bakelite forms insure accurate space winding, thus reducing the distributed capacity, and keep the number of turns and separation constant. Hence the secondary reactances are identical and ideal for gang tuning.

The radio frequency transformer may be perpendicularly or horizontally mounted, and has braced holes for that purpose. It has a center-tapped primary, so that it may be used as antenna coil with half or all the primary in circuit, or as interstage coupler, with all the primary on a screen grid plate circuit, or half the primary for any other type tubes, including pentodes. The three-circuit tuner has a center-tapped primary, also. This tuner is of the single hole panel mount, but may be mounted on a chassis, if preferred, by using the braced holes. Pair consists of RF transformer and three-circuit tuner, both for .0005 mfd. only. Order Cat. G-RF-3CT. List price \$5.00; net price \$2.48



Shielded Lead-in Wire



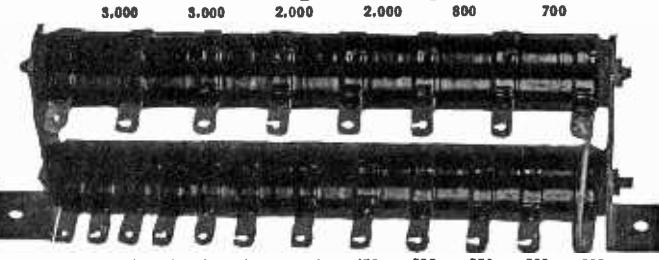
No 18 solid wire, surrounded by a solid rubber insulation covering, and above that a covering of braided copper mesh wire, which braid is to be grounded, to prevent stray pick-up. This wire is exceptionally good for antenna lead-in, to avoid pick-up of man-made static, such as from electrical machines. Also used to advantage in the wiring of receivers, as from antenna post of set to antenna coil, or for plate leads, or any leads, if long. This method of wiring a set improves selectivity and reduces hum. This wire is now appearing on the general market for the first time although long used in the best grade of commercial receivers. Order Cat. SH-LW. List price 9c per ft.; net price per foot 5c

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(Just East of Broadway)

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express or post office money order, for which please ship:
 Balkite comp. \$56.57 Ft. of SH-LW M-600 @.... \$4.95
 MTVD @... 3.90 5c p. f. F-300 @.... \$2.50
 G-RF-3CT @ 2.48 H-DDD @... \$3.00 F-500 @.... 3.75
 R-245 @.... 11.40 SH-RFC @... 50c MICON.... @....
 If C.O.D. shipment is desired put cross here.

Your Name
Address
City..... State.....

New Multi-Tap Voltage Divider



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The resistance values between the twenty taps of the new Multi-Tap Voltage Divider are given above. The total is 17,100 ohms and affords nineteen different voltages.

The Multi-Tap Voltage Divider is useful in all circuits, including push-pull and single-sided ones, in which the current rating of 100 milliamperes is not seriously exceeded and the maximum voltage is not more than 400 volts. Higher voltages may be used at lesser drain.

The expertness of design and construction will be appreciated by those whose knowledge teaches them to appreciate parts finely made.

When the Multi-Tap Voltage Divider is placed across the filtered output of a B supply which serves a receiver, the voltages are in proportion to the current flowing through the various resistances. By making connection of grid returns to ground, the lower voltages may be used for negative bias by connecting filament center, or, in 227 and 224 tubes, cathode to a higher voltage.

If push-pull is used, the current in the biasing section is almost doubled, so the midtap of the power tubes' filament winding would go to a lug about half way down on the lower bank.

Order Cat. MTVD, list price \$6.50, net price.....

\$3.90

R-245 Set and Tube Tester

With the R-245 Tube and Set Tester you plug the cable into a vacated socket of a receiver, putting the removed tube in the tester, and using the receiver's power for making these tests: Plate current, on 0-20 or 0-100 ma. scale, changed by throwing a built-in switch; 0-60, 0-300 v. DC, changed by moving one of the tipped cables to another jack; filament or heater voltage (AC or DC), up to 16 volts, or any other AC voltage source, measured independently, up to 140 volts, including AC line voltage. Also screen grid voltage and screen grid current may be read by following connections specified in the new 8-page instruction sheet.

Each meter may be used independently. The two test leads, one red, the other black, with tip jack terminals, enable quick connections to meters for independent use.

With this outfit you can shoot trouble in receivers and test circuits using the following tubes: 201A, 200A, UX119, UX120, 210, 171, 171A, 112, 112A, 225, 224, 222, 226, 227, and pentodes.

When the R-245 is plugged into the vacated socket of a set and the removed tube is placed in the proper socket of the Tester, the receiver's power supplies all the voltages and currents. You see the vital tests made right before your eyes, all three meters registering immediately all three readings at the same time.

Here are some of the questions answered by the Tester when plugged into the receiver:

What is the filament or heater voltage (no matter if DC or AC)? What is the plate voltage at the plate itself? What is the plate current drawn by the tube? Is the tube in good condition or does it require replacement? What is the grid bias voltage? What is the cathode voltage? What is the screen grid voltage? Besides, when meters are used independently, you can answer these questions: What is the screen grid current? What is the line voltage (no matter if AC or DC)? Is the circuit continuous or is it open? What is the total plate current drawn in the receiver? What are the respective B voltages at the B batteries or voltage divider?

Order Cat. R-245. List price, \$20; net price.....

\$11.40

Fixed Condensers



Dubilier Micon fixed condensers, type 642, are available at following capacities and prices:

.0001 mfd.	10c	.008	20c
.00025 mfd.	10c	.00025 with clips.	20c
.0003 mfd.	10c	All are guaranteed	
.00035 mfd.	15c	electrically perfect and	
.001	17c	money back if not	
.0015	17c	satisfied within five	
.002	18c	days.	

Order Cat. MICON .0001 etc. at prices stated.

High-Voltage Meters



0-300 v., 200 ohms per volt. Cat. F-800 @ \$2.50
0-500 v., 238 o.p.v. Cat. F-500 @..... 3.75
0-600 v., AC and DC (same meter reads both); 100 ohms D.V. Order Cat. M-600 @ 4.95

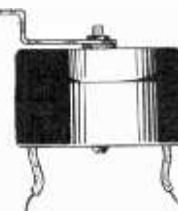
Double Drum Dial



Hammarlund double drum dial, each section individually tunable. Order Cat. H-DDD. List price \$8.00; net price \$3.00

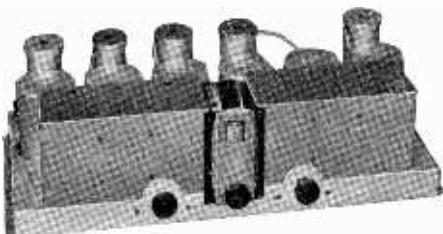
Shielded RF Choke

Excellent in detector plate circuit or in B-plus RF leads of radio frequency tubes to for all RF shunting. An efficient radio frequency choke in a shielded case. Inductance, 50 millihenries. Useful for purifying signals.



Order Cat. SH-RFC. List price \$1.00; net price

Parts for the Best Circuits



NEW NATIONAL DE LUXE MB-30 SCREEN GRID TUNER—This is one of the most sensitive tuners ever developed, averaging 1 microvolt per meter, and at some frequencies attaining $\frac{1}{2}$ microvolt per meter. Its selectivity is most remarkable and without material sideband cutting, or to use of Vreeland band pass filter and pre-selector circuits. Six tuned circuits, perfectly aligned and tested with laboratory equipment that cost more than \$1,000. The circuit, which is for AC only, uses four 224 and one 227 tubes, and requires a power amplifier that will power the heaters as well. All parts mounted on chassis ready for wiring. Steel chassis, $21\frac{1}{2} \times 10\frac{3}{4} \times 1\frac{1}{2}$. Order Cat. MB-30-P, list price \$85 less tubes; net price.....\$48.97
WIRED MODEL, Cat. MB-30-W, list price \$95 less tubes; net price.....\$54.86

MB-29-A TUNER—a smaller version of the MB-30, using four instead of six tuned circuits, but including also the pre-selector and band pass filter circuits. Uses three 224 and one 227. Aluminum chassis $15\frac{1}{4} \times 10\frac{1}{4} \times 1\frac{1}{2}$. Order Cat. MB-29-AP, list price \$69.50 less tubes; net price.....\$40.86

WIRED MODEL, Cat. MB-29-AW, list price \$79.50, less tubes; net price.....\$46.74

NATIONAL VELVETONE Push-Pull Power Amplifier, using one 227, two 245's and one 280; two stages of transformer coupling, with output transformer; heater voltage for five extra tubes; plate voltage for tuner. A matched unit for the MB-30 or MB-29-A. Phonograph jack built in. Velvetone comes completely wired. Licensed by RCA. Order Cat. PPPA, list price \$97.50, less tubes; net price.....\$57.33

HAMMARLUND HI-Q-31—The latest development in custom-set building, a 9-tube circuit, using a 3-stage band-pass filter pre-selector, three stages of 224 RF, 224 power detector, 227 first audio, two 245's for push-pull output, and a voltage regulator tube. Chassis is $23\frac{1}{2} \times 12\frac{1}{2} \times 4\frac{1}{2}$. Order Cat. AC-31-R, list price of complete parts. \$159.80, less tubes; net price.....\$91.06

WIRED MODEL HI-Q-31—Order Cat. AC-31-RW, list price \$184.80, less tubes; net price.....\$111.05

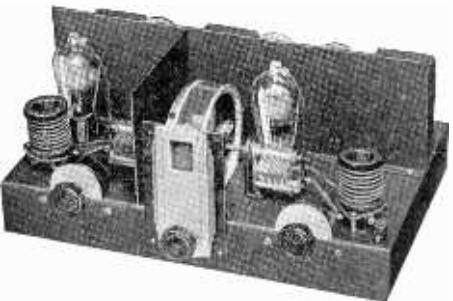
HI-Q AC TUNER WITH POWER SUPPLY (less supply)—Order Cat. AC-31-TPS, list price \$148.55, less tubes; net price.....\$82.78

HI-Q-AC TUNER ONLY (for use with external power supply)—Order Cat. AC-31-T, list price \$107.20, less tubes; net price.....\$61.09

HI-Q-31 FOR BATTERY OPERATION—Order Cat. BAT-31-R, list price \$119.55, less tubes; net price.....\$68.14

HI-Q-31 TUNER FOR BATTERY OPERATION (less audio)—Order Cat. BAT-31-T, list price \$102.95, less tubes; net price.....\$58.69

Short Waves



NATIONAL 5-TUBE THRILL BOX—A remarkably sensitive short-wave outfit, noted for reception of foreign stations. Uses 224 RF, 224 detector, 227 first audio, 227 push-pull second audio. A separate A and B supply is required. See below. Standard set of four pairs of coils included (21.2 to 2.61 megacycles). Humless operation, even on headphones. Single tuning control. No grunting, no backlash, no hand capacity. Order Cat. AC-SW-5, list price, less tubes, less B supply, \$79.50; net price.....\$46.74

NATIONAL SW POWER UNIT—Furnishes heater voltage and B voltage for the AC Thrill Box. Uses 280 rectifier. Comes in wired form only. Licensed under RCA patents. Order Cat. 5880, list price, less tube, \$34.50; net price.....\$20.28

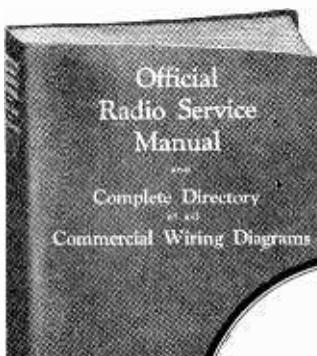
BATTERY MODEL THRILL BOX—This uses the new 2-volt tubes; two 232 screen grid, three 230 and one 231, in same general circuit. Order Cat. DC-SW-5, list price \$75; net price.....\$44.10

WIRED MODEL AC THRILL BOX—Order Cat. AC-SW-5-W, list price \$89.50, less tubes, less power unit; net price.....\$52.62

WIRED MODEL BATTERY THRILL BOX—Order Cat. DC-SW-5-W, list price \$85, less tubes; net price.....\$49.98

HAMMARLUND SW TUNER—For one stage of RF and detector; battery operation; uses two 230 tubes or any other pair of battery-operated general purpose tubes. Coils cover 15 to 105 meters. Order Cat. SWR-2, list price \$36, less tubes; net price.....\$21.15

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"OFFICIAL RADIO SERVICE MANUAL"

recently published, contains more than ONE THOUSAND illustrations, diagrams, etc., of commercial receivers, power amplifiers, tuners, and radio accessories. There are 352 PAGES in this looseleaf, leatherette-covered book. The weight of the book is $2\frac{1}{2}$ IBS. Within its pages is a diagram of every commercial radio circuit, receiver or otherwise, available at the time of going to press. The looseleaf feature permits adding 1931 diagrams when they are ready. It is intended to sell these later diagrams at a small extra cost.

Prepared especially for the service man, this book is not only an official directory of circuits, an encyclopedia of schematic and pictorial wiring diagrams, but it has 67 pages of instructions on servicing, well illustrated and authoritatively written. Eleven chapters constitute this course on servicing. The chapter titles are: Service Equipment, telling what's needed and how to use it; General Service Procedure; Power Supply Systems; Vacuum Tubes, with tables of characteristics; Loudspeaker, with detailed construction drawings; The Antenna System; Radio Frequency Amplifiers; Detectors; Audio Frequency Amplifiers; Extraneous Noise and Their Origin; Radio-Phonograph Combinations; Short-Wave Sets and Automotive Installations; Standard Radio Symbois; Formulas for Resistance Values.

The index to the commercial wiring diagrams takes up five pages alone. The Index is an alphabetical array of the manufacturers' names, with model names and numbers stated.

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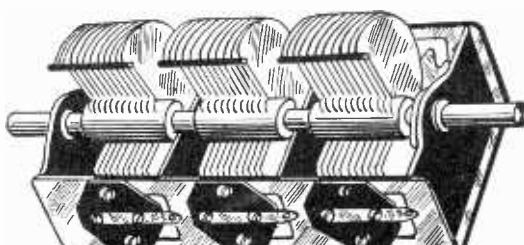
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Flexible insulated coupled for uniting coil or condenser shafts of $\frac{1}{4}$ inch diameter. Provides option of insulated circuits on both sides. Order Cat. FL-C @.....\$0
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Antenna coil for .00035 mfd. Order Cat. ANT-3 @.....\$0
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Screen grid RF transformer, for .0005 mfd. to couple screen grid tube to next tube. Order Cat. SG-5 @.....\$0
Screen grid RF transformer, for .00035 mfd., to couple screen grid tube to next tube. Order Cat. SG-3 @.....\$0
AC electric motor and turntable, for playing phonograph records. A synchronous motor, 60 cycles; 80 turntable revolutions per minute. Order Cat. SYN-M @.....\$0
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A eliminator or dynamic speaker transformer (Jefferson), 20-volt secondary. Will pass $2\frac{1}{2}$ amps. Order Cat. 20-V-T @.....\$0
30-henry shielded choke for B supply filtration or filtered speaker output. Will stand 80 ma. Order Cat. OS-30HS @.....\$0
60-henry shielded center-tapped choke (30 each side of center) for B supply filtration or filtered output of push-pull tubes. Will stand 80 ma. Order Cat. OS-60HCT @.....\$0

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<input type="checkbox"/> 0-25 Milliamperes D.C.	No. 325
<input type="checkbox"/> 0-50 Milliamperes D.C.	No. 350
<input type="checkbox"/> 0-100 Milliamperes D.C.	No. 390
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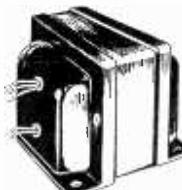
245 POWER TRANSFORMER

The 245 power transformer is for use with a 280 rectifier tube, to deliver 300 volts DC at 100 milliamperes, slightly higher voltage at lower drain, from a 110-volt AC line, 50-60 cycles. The primary is tapped at 82½ volts in case a voltage regulator (Clarostat or Amperite) is used. The black primary lead is common. If no voltage regulator is used the other primary lead is the green one, so tape the end of the red. If regulator is used, tape the end of the green and use the red with the black. The secondary voltages are all center tapped: 672 volts AC for 280 plates, 2½ v. 3 amps. for 245 output single or push-pull; 5 v. 2 amps. for 280 filament; 2½ volts 16 amps. for up to eight 224 or 227 tubes. Center taps are red and all leads are identified on name plate. The core is larger than formerly and won't saturate at 100 ma. Laminations hidden except at bottom. Eight-inch leads emerge from the sides, but if preferred may be taken off through the bottom of the transformer by pushing them through the rubber grommets. Shipping weight, 12 lbs. Overall size, 5" from left to right as illustrated; 4¾" from bulging bell end to other bell end; 4¾" high.
Order Cat. 245-PT (12 lbs.) @ \$ 9.50
For 40 cycles order Cat. 245-PT-40
(14 lbs.) @ 10.50
For 25 cycles order Cat. 245-PT-25
(16 lbs.) @ 12.00

250 POWER TRANSFORMER

The 250 power transformer supplies voltages for two 281 rectifiers, to power 250 output, single or push-pull. The secondaries all center-tapped, are 1,200 volts AC for 281 plates; 7½ v. 3 amps. for two 281s; 7½ v. 3 amps. for one or two 250s; and 2½ volts, 16 amps. for up to eight 224s and 227s. 5" x 5½" x 4¾"; shipping weight, 16 lbs.
Order Cat. 250-PT (16 lbs.) @ \$12.50
For 40 cycles, order Cat. 250-PT-40
(18 lbs.) @ 13.50
For 25 cycles, order Cat. 250-PT-25
(20 lbs.) @ 15.00

245 CHOKES COIL



100 ma choke coil
for B filtration
in 245 push-pull
or single 245 circuits,
200 ohms
DC resistance, inductance 30
henrys, a continuous winding
tapped in two places, giving
three sections and four
outleads, and permitting a "choke
input" to filter.
By this method rectifier tube life and filter
condenser life are lengthened yet filtration is
splendid. The black lead goes to the rectifier
filament center, the red, green and yellow
leads are next in order. Capacities suggested:
black, none; red, 1 mfd.; green, 8 mfd.; yellow,
8 mfd. In shielded polished aluminum case.
Shipping weight, 4 lbs. Order Cat. 245-CH @ \$4.00
[We can supply the high voltage condensers
as follows: 1 mfd., paper dielectric, @ \$1.50
each; 8 mfd. electrolytic @ \$1.50 each.]

250 CHOKES COIL

A larger choke is used for the 250 type B supply,
consisting of a continuous winding tapped. In-
ductance, 40 henrys, DC resistance 150 ohms.
Shipping weight, 5 lbs. Order Cat. 250-CH @ \$5.00

CENTER-TAPPED CHOKE

30 henrys, 150 ohms DC resistance, 100 ma rat-
ing, with two black leads emerging, and red
center tap. For use in 245 or 250 push-pull out-
put where a dynamic speaker that has its own
output transformer is used. The impedances are
thus satisfactorily matched. Connect the black
leads to the plates of the push-pull tubes and the
red to positive B. The tipped cords of the
speaker (or primary of the output transformer
built into the speaker) go to the plates also.
Connection must not be made direct from plates
to voice coil. This choke may also be used in-
stead for filtration of B supplies, either as a
single choke, by ignoring the red lead, or as a
double by using all three leads. Either black lead
would go to rectifier. Shipping weight, 4 lbs. Order Cat. CT-CH @ \$3.50

SPECIAL FILAMENT TRANSFORMER
A special filament transformer, 110 v., 50-60
cycles, with two secondaries, one of 2½ v. 3 amp.
for 245s, single or push-pull, other 2½ v. 12
amperes for up to six 224, 227, etc. both
secondaries center-tapped. Shielded case, 6 ft.
AC cable, with plug. Shipping weight, 4 lbs.
Order Cat. SP-FLT (4 lbs.) @ \$4.25
For 40 cycles, Cat. SP-FLT-40 (5 lbs.) @ 5.00
For 25 cycles, Cat. SP-FLT-25 (6½ lbs.) @ 6.00
POLO ENGINEERING LABORATORIES
143 West 45th Street, New York, N. Y.



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EVERY WEEK — EVERY YEAR

RADIO WORLD

Vol. XVIII, No. 5 Whole No. 447
October 18th, 1930
[Entered as second-class matter, March,
1922, at the Post Office at New York,
N. Y., under act of March, 1879]
15c per Copy, \$6.00 per Year

NINTH YEAR
Latest Circuits and News
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A Weekly Paper published by Hennessy
Radio Publications Corporation, from
Publication Office, 145 West 45th Street,
New York, N. Y.
(Just East of Broadway)
Telephone, BRYant 0558 and 0559

RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke, Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, Secretary, 145 West 45th Street, New York, N. Y.; Roland Burke, Hennessy, editor; Herman Bernard, business manager and managing editor; J. E. Anderson, technical editor.

Tuned Impedance RF

By Herbert E. Hayden

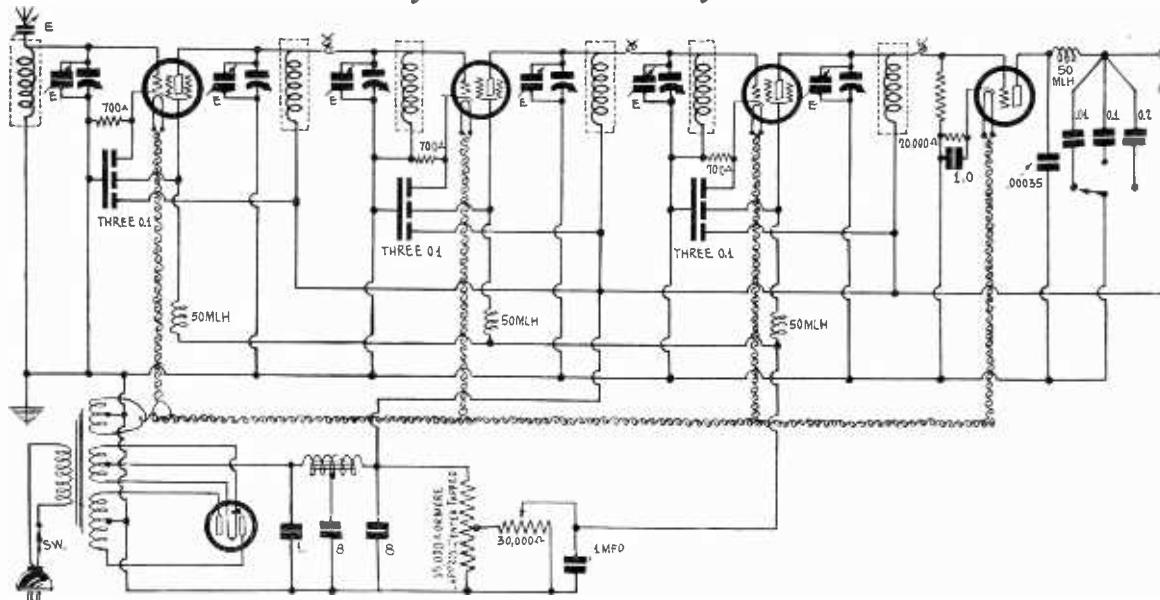


FIG. 1

A TUNER WITH B SUPPLY, USING TUNED IMPEDANCE COUPLING BETWEEN RADIO FREQUENCY STAGES. THE OUTPUT IS TO BE DELIVERED TO A POWER AMPLIFIER. A DEGREE OF AUTOMATIC VOLUME CONTROL RESULTS FROM THE USE OF 700-OHM BIASING RESISTORS FOR THE AMPLIFIERS. THE SWITCH IN THE CONDENSER PLATE CIRCUIT OPERATES A TONE CONTROL. THERE ARE SIX TUNED CIRCUITS AND THREE STAGES OF TRF.

THE general trend to-day is to use a greater number of tuned circuits than there are radio frequency amplifying tubes. So we find pre-selector circuits, which tune to the signal frequency rather sharply before there is any input to a tube, while the coupling between tubes is tuned likewise. Band pass filter circuits usually are included in pre-selectors, and sometimes also in the inter-stage tuned circuits. It is therefore obvious that engineers believe that enough amplification is available, but that selectivity bothers them, until more tuned circuits remove this trouble. So that the increase in selectivity will not be accompanied by serious sideband cutting, the band pass filter circuits are included.

An excellent way of using a greater number of tuned circuits without increasing the number of tubes is to resort to tuned impedance coupling. Both the plate and the grid circuits may be tuned, although this requires the use of screen grid tubes, since general purpose tubes will oscillate violently if the plate circuits are tuned.

How tuned impedance is used may be seen from Fig. 1. The input is of the same type of tuning, except without transformation, and as a low value of coupling to the antenna is required under such circumstances, it is effectuated by putting an equalizing condenser, E, in series with the antenna. The degree of coupling may be made whatever is preferable for a given location within the range of the condenser, 20 to 100 mmfd. Once this setting is established it need not be molested. The low value of condenser used for antenna coupling also makes possible synchronism of the circuits, although a gang condenser is used. Across each section of the gang condensers is an equalizer, E, of the same capacity range, 20 to 100 mmfd.

Ignoring the antenna input, we get two tuned stages where

in usual practice we have one such stage between tubes. The rub comes in the coupling. Each tuned coil is shielded and is separated from all other coils, physically and electrically. Hence to join a tuned plate with a succeeding tuned grid a condenser may be used. This would connect between plate of one stage and grid of the next.

The question arises as to what should be the value of this condenser. Here is where a surprise is in store for many. It should be of such a small capacity that it is doubtful if one in a hundred dealers has a commercial product of this low value of capacity, of the order of 1 mmfd. (.000001 mfd).

It is easy enough, however, to get around this by using an excess length of the insulated wire connecting the coil to the tuning condenser in each instance, and twisting these together.

The symbols that resemble cornucopias are intended to represent such twisted pair. After the right amount of coupling has been established a piece of soft rubber tubing may be placed over the joint, and allowed to protrude a little beyond the ends of the wire, so that there will be no possibility of shorting, due to the wires touching each other conductively, or either or both being grounded to a metal chassis, or the like.

Not only is it necessary for selectivity reasons to have the coupling small, as established by the capacity thus developed between the two wire leads which act as plates of the improvised condenser, but if the coupling is strong (say, that represented by 25 mmfd. or more), then the two tuned circuits tend to pull together, that is, to merge in familiar parallel connection. This would spoil the whole scheme, since the situation would amount practically to a single tuned circuit of half the desired inductance and twice the desired capacity. Other circuits

(Continued on next page)

An Easy Way to

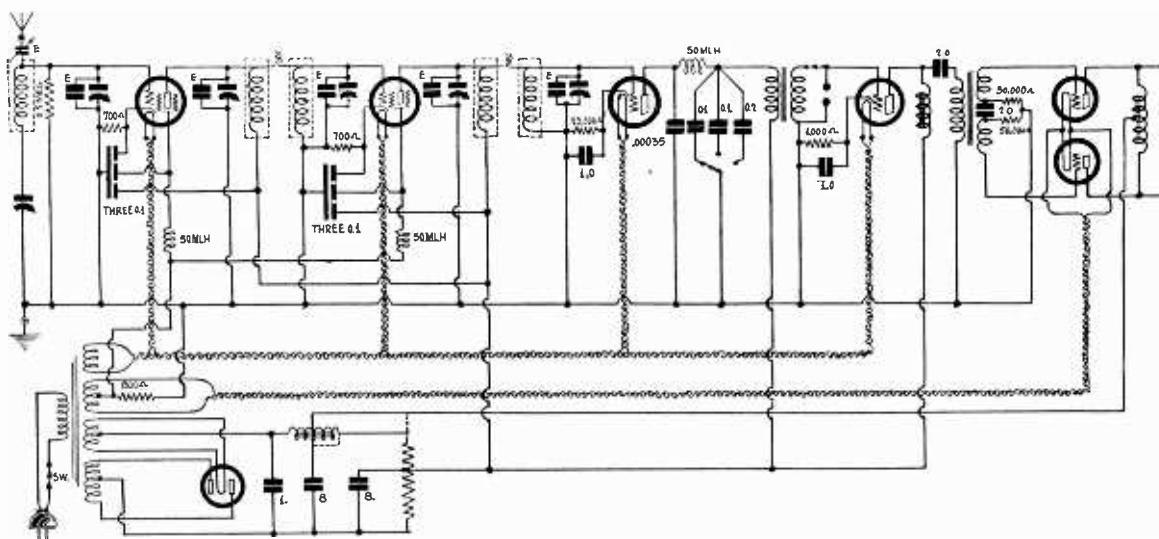


FIG. 2
A COMPLETE RECEIVER, USING TUNED IMPEDANCE COUPLING AT RADIO FREQUENCIES. THERE ARE FIVE TUNED CIRCUITS, ALTHOUGH TWO THREE-GANG CONDENSERS ARE USED, SINGLE CONTROL. ONE SECTION REDUCES THE ANTENNA COUPLING AT THE HIGHER FREQUENCIES, TO MAKE THE AMPLITUDES MORE NEARLY ALIKE. THERE ARE TWO STAGES OF TRF.

(Continued from preceding page)
attempting to utilize the tuned double impedance radio frequency system have failed for this very reason.

Band Pass Filter System

By making the tuned circuits slightly dissimilar, that is, not strictly resonant at any given setting of the tuning condenser, the fundamental nature of the circuit is altered from tuned radio frequency amplification, which means each stage tuned to the same frequency, to a band pass filter.

Hence if the plate circuits were made resonant to a particular frequency at about the geometric mean of the broadcast frequency spectrum, the grid circuits could be made resonant to a frequency, say, of 10,000 cycles removed from the other, which would produce a band pass filter effect, with relatively flat top, at the middle of the tuning divergence, represented theoretically by the 5,000-cycle point.

It would really be a double hump top, and the amplification would be reduced somewhat, an effect naturally to be expected from off-resonance conditions, but the "opening" for the carrier frequency would be wider, and since there are six tuned circuits, in many locations this "opening" would be readily made of practical value without interference trouble.

The tuning capacities would consist of two three-gang condensers, one gang on one side, the other gang on the other side of a drum dial.

Coil Data

Those who have shielded coils of the same type and manufacture, suitable for the capacities of condensers used, may incorporate the system of double tuned impedance RF coupling, for even if the coils have primaries, these may be left unused.

For those who desire to wind their own coils it is hard to give winding data, unless the size of the shield and its material are known. Different sizes of shields produce different degrees of eddy current or energy absorption losses, and the inductance is less, the smaller the shield, or, granting a certain size shield, the inductance is less, the greater the diameter of the form on which the coil is wound, compared with equal unshielded inductance in both instances. Also, the material has something to do with it, iron and steel having greater loss-producing effects for radio frequency shielding.

Use .0005 Mfd.

Because of these shield effects it is usually unsafe to use a capacity of .00035 mfd. for tuning. In fact, the author knows of no circuit that uses completely shielded coils that fully covers the wave band with .00035 mfd. capacity, but does recall that when the first Neutrodyne was brought out with three stages of TRF (replacing the two-stage TRF circuit that had made the Neutrodyne so popular in its day), the capacity for tuning was .00075, instead of the previous .00035 mfd., due to these very shield effects.

So it is always better in shielded circuits to select .0005 mfd. Some condensers made for set manufacturers, and which may

be picked up at low prices, have a capacity of .00045 mfd., and this is high enough. But nothing less than .00045 mfd. will do, unless the shield is made of a "low-loss" metal and is much larger in diameter or in width (if square or oblong) than we come across nowadays.

Number of Turns

There are two sizes of round aluminum shields of the can type generally available at a quarter each, one about $2\frac{1}{4}$ inches in diameter and the other about $3\frac{1}{4}$ inches.

For the smaller type aluminum can, on a $1\frac{3}{4}$ inch diameter

Right or

QUESTIONS

(1)—Plate bend detection is equally efficient for all negative grid voltages because the relation between the grid voltage and the plate current is parabolic, and such a characteristic has the same change in slope everywhere.

(2)—There is no advantage in using a push-pull stage of large power tubes after a voltage amplifier when the tubes in that amplifier are small and cannot deliver undistorted voltage.

(3)—There is no current flowing between the heater and the cathode of a 227 or a 224 tube because there is no voltage between them.

(4)—If a condenser is connected in series with the primary of a transformer the impedance of which is very high, a relatively small condenser will suffice because even at the low notes the greater drop will be across the primary. It is for this reason that a condenser as low as 2 mfd. will pass the low notes without appreciable suppression compared with the high notes.

(5)—It is not possible to obtain distortionless amplification from a single tube whether the coupling is resistive or inductive because the relation between the grid voltage and the plate current is not a straight line.

(6)—A resistance placed in the cathode lead or in the return to the filament transformer and used for biasing the grids takes the voltage from the plate supply and consequently it is necessary to apply a voltage equal to the sum of the desired plate and grid voltages.

(7)—If a very sharp tuner cuts sidebands and so introduces distortion all that is necessary to remedy the condition is to assume that sidebands do not exist and that the modulated wave consists of a carrier modulated in amplitude. The distortion will not occur then.

ANSWERS

(1)—Wrong. The optimum voltage for detection is very critical. It would not be if the characteristic curve were a parabola, but it is not although it is considered to be in certain applications. The point of maximum detecting efficiency is where the plate current

Modernize Old Sets

bakelite tubing, for .0005 mfd. tuning, wind 70 turns of insulated wire. The size of the wire may be No. 24 or No. 28. The No. 24 wire is usually silk or cotton covered, or the like, while the No. 28 wire is usually enamel covered.

For the larger aluminum can, wind 68 turns, choosing the wire as previously stated.

No directions will be given for .00035 mfd., because the use of this capacity is discontenanced. Also, any smaller capacity would be useless for full waveband coverage, while larger tuning capacities than .0005 mfd. are not generally obtainable.

Completion of Tuned Circuit

The tuning condensers' rotor is common and is grounded. Three stator sections are in plate circuits. The tuned circuit in these instances is completed through one section of the three-in-one 0.1 mfd. assemblies and the 8 mfd. in the reservoir position (extreme right) of the B supply. These two condensers are in parallel, and 0.1 mfd. would be lost as compared with 8 mfd., except that in the layout of parts the lead from the "low" end of the plate winding to B plus may be more than a few inches, and by connecting the 0.1 mfd. at the coil terminal the tuned circuit is completed to ground, with a bypass effect on the long lead.

The B supply uses a power transformer that produces a DC output of 180 volts, by virtue of a 5-volt winding for the 280 filament and a center-tapped 420-volt AC secondary. The other winding is 2.5 volts for the heaters of the four tubes—three RF and detector.

Automatic Volume Control

The bias on the radio frequency amplifiers is higher than ordinarily recommended. The usual 1.5 volts negative bias will modulate downward; that is, increased carrier intensity will decrease the plate current. The bias, if lifted to 3 volts or a little more, as when 700 ohms is used instead of 300 ohms, will result in upward modulation, so that with increased carrier intensity the bias increases, due to more current through the biasing resistor heightening the voltage drop across that resistor. This is a measure of automatic volume control, simply established, since the heightened bias, due to higher carrier intensity, finally increases the plate resistance and reduces the sensitivity, hence volume. This produces a relative levelling effect.

Fig. 2 shows a seven-tube circuit, consisting of two stages of screen-grid RF, detector, first stage single-sided transformer

audio coupling and output push-pull 245s, with 280 rectifier. The transformers are Amertran de luxe and 151. The same general plan is followed as in the tuner shown in Fig. 1, except that there are only two stages of TRF instead of three, and the audio is included, with 300 volts of B supply and the other necessary voltages for the 245s.

Compensated Pickup

The same arrangement of the tuning condensers would be followed, but there are really only five tuned circuits. The other section is used for cutting down the pickup on the higher radio frequencies, to compensate somewhat for the rising characteristic of tuned radio frequency amplification. Every one is familiar with the greater amplification on the higher frequencies, so if an arrangement is used that does not cut down the pickup on the lower frequencies to any real extent, but is strongly effective on the higher frequencies, the device will be a fitting auxiliary to the automatic volume control feature. Since the effects of both are relative, and since they work in the same direction, the benefit becomes more pronounced and more tangible.

Sometimes a constructor complains that the voltage reading obtained on the power tubes is too low, or, occasionally, too high. The arrangement shown in heavy lines in Fig. 2 for obtaining the power tubes' B voltage from the center tap of the B choke produces a higher voltage. The arrangement shown in dotted line will produce a lower voltage, because the B current for the output tubes would have to pass through the other second section of the center-tapped choke coil, and the DC resistance of this part of the coil would reduce the voltage.

If the voltage is taken off the end, move the second 8 mfd. to the end, as the extra dotted line indicates.

So use whichever connection produces the desired result, in the event of an off-voltage.

Voltage Readings

The correct voltage readings would be 250 volts from voltage divider maximum to center of the 2.5-volt winding for the power tubes, 50 volts from this filament center to ground; total across voltage divider, 300 volts. Less than 250 volts would be read by plugging into the power tube socket with a Jiffy Tester or the like, because then the DC resistance of the center-tapped output impedance would be in circuit.

The detector plate current reading frequently can not be obtained because the meter is not sensitive enough. The current may be less than 1 ma.

If resistance audio amplification follows the detector, the detector plate voltage can not be read on the meter, either, as this would show up as about 5 volts, which doesn't mean there are only 5 volts at this point, but that you are reading only the meter error, due to the resistance of the measured circuit being so much greater than that of the measuring device. Much more current flows through the meter than through the load.

Tubes can be "gained" by the double tuned impedance RF system, and it is handy to have a general idea of the circuit in mind in case you desire to modernize an old receiver. Then you can provide for screen grid RF, push-pull audio, tone control, automatic volume control and the like, and not require any more room than the chassis affords. You could put in coils of your own make, use shields where none was used before, and, most important of all, get very fine results in sensitivity, selectivity and tone.

Parallel Resistance Formula

Most of us are familiar with the customary parallel resistance

$$\text{formula, } R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

tally. Add the two fractions in the denominator and we have

$$R = \frac{1}{\frac{R_1 R_2}{R_1 + R_2}} \text{ and then clearing of fractions we have } R = \frac{R_1 + R_2}{R_1 R_2}$$

and this is a very convenient form to use. Just multiply the values of the two resistances together and divide by the sum of the two resistances.

For example, a two and three-ohm resistance in parallel would have a resistance of two times three or six divided by two and three or five, one and 1/6 ohms resistance. Or take a three and a six-ohm resistance in parallel $3 \times 6 / (3+6) = 2$ ohms. This form of equation eliminates all need of reciprocal figures and unhandy fractions, but applies only to two resistors.

ORA G. FRETZ.

Wrong?

just stops, or a little higher, that is, a little nearer the zero bias point. It is usually said that it is at the point of greatest curvature, but this is not exactly true either because it depends also on the slope of the curve.

(2)—Right. If the signal is distorted before it reaches the push-pull amplifier there is no use in putting in large tubes to amplify the distortion still more. Moreover, the push-pull amplifier cannot take out any distortion. It can only prevent the generation of more distortion in that stage alone.

(3)—Wrong. There is a small current because the filament emits electrons and shoots them over to the cathode. Of course, if there is no circuit established there can be no permanent current flowing, but there usually is a complete circuit, formed by connecting the center point of the filament winding to ground, where the cathode is also connected.

(4)—Right. The suppression by the condenser on any frequency depends on the relative impedance of the condenser and the primary of the transformer. If the primary of the transformer has an inductance of 200 henries its impedance at 60 cycles is about 75,000 ohms. A condenser of 2 mfd. has an impedance at the same frequency of 1,324 ohms. Hence the total suppression at this frequency can only be about 18 per cent.

(5)—Right. What is meant by distortionless amplification is that which gives an amplified signal containing not more than a certain specified amount of second harmonic content, usually 5 per cent. The distortion may be less than this on weak signals but it is never absent. When there are two tubes of equal characteristics operating in tandem in equal circuits the distortion is less than when a single tube is used. Also, when two equal tubes are operated in equal circuits in push-pull the distortion is still less.

(6)—Right. The grid bias resistor is really in the plate circuit and any drop in it must necessarily be taken from the voltage applied in the plate circuit. The connection of the grid return to a point of lower potential than that of the cathode has nothing to do with it, except insuring a negative potential for the grid.

(7)—Wrong. As ridiculous as the statement may seem, it is actually believed to be true by some, and claimed to be true by others who know better but who are pressed for an explanation of reception through very sharp tuners.

The 245 and the

By J. E.

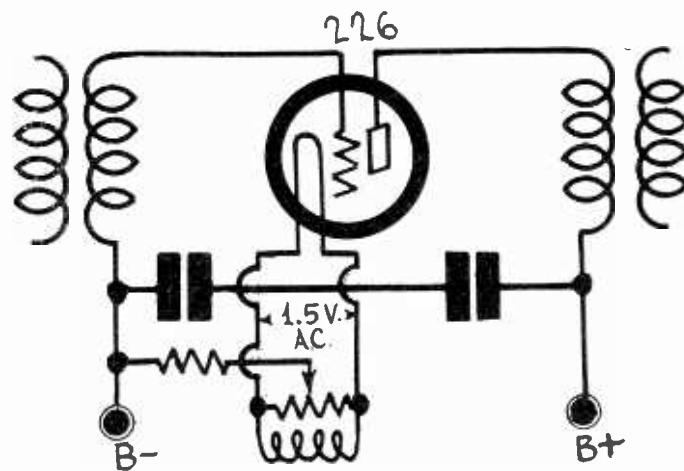


FIG. 84

WHEN THE TRANSFORMER WINDING IS NOT CENTER-TAPPED, OR WHEN MORE ACCURATE BALANCING IS DESIRED, THE GRID SHOULD BE RETURNED TO AN ADJUSTABLE SLIDER ON A RESISTOR ACROSS THE FILAMENT

[This is the eleventh instalment of "Modern Radio Tubes," a series of articles which began in the August 9th issue. In previous instalments we have discussed all the smaller receiving tubes and given their characteristics. In future instalments we shall discuss the 250 power tube and many special purpose tubes.—EDITOR.]

Fig. 82 shows that the 226 is not the only tube in which the hum is least for a particular value of plate current. It also shows the advantage of the 226 over the other two tubes represented. The 226 shows a minimum ripple between 3 and 4 milliamperes and the amount of ripple at minimum is less than 10 millivolts. For the 112 the minimum occurs between 9 and 10 milliamperes, but the ripple is about 120 millivolts. For the 201A tube the minimum occurs at 5 milliamperes and the amount at that point is about 370 millivolts. The filament and grid bias voltages at which these curves were taken are given on the graph. It is important to note that not only is the hum much less at minimum for the 226 than for the others at their minima, but the variations on both sides of the minima are much greater for the 112 and the 201A than for the 226.

210

THE 210 is a power tube that may be used as a power amplifier in a receiving set, as a modulator in a transformer, or as an oscillator. Its rated filament voltage is 7.5 volts, which may be either AC or DC, and its rated filament current is 1.25 amperes. The filament is of the thoriated tungsten type, which may be reactivated in case the filament emission has ceased because of an overload.

The bulb of this tube is larger than the bulb used for the 5-volt tubes, the maximum overall length being 5 $\frac{5}{8}$ inches and the maximum diameter 2 3-16 inches. The base, however, is the same as that for the five-volt tube, being the standard UX base, and it fits a standard socket.

For all purposes the filament voltage should be 7.5 volts and the filament current 1.25 amperes. Plate and grid bias voltages depend on the application of the tube. When the tube is used as voltage amplifier in a radio receiving set the plate voltage may be any value from 180 to 425 volts and the corresponding bias from 10 to 35 volts. When the tube is used as oscillator, modulator or power amplifier in a transmitting set the plate voltage should be 350 volts, the grid bias depending on the application. The maximum safe dissipation on the plate is 12 watts when the tube is used as amplifier and modulator and 15 watts when it is used as oscillator. This power is not the maximum undistorted output, but the power dissipated on the plate in the form of heat.

When the grid bias is provided by means of a resistor, the value of the resistance may vary between 1,500 and 1,750 ohms, which are the extreme values determined from the listed grid voltages and plate currents in the table below. The mean resistance for the four cases is 1,661 ohms, so that if the grid bias resistor is adjustable it should be set at this value, but if a fixed resistance is used either 1,500 or 1,750 ohms will do. Both of these are standard commercial values.

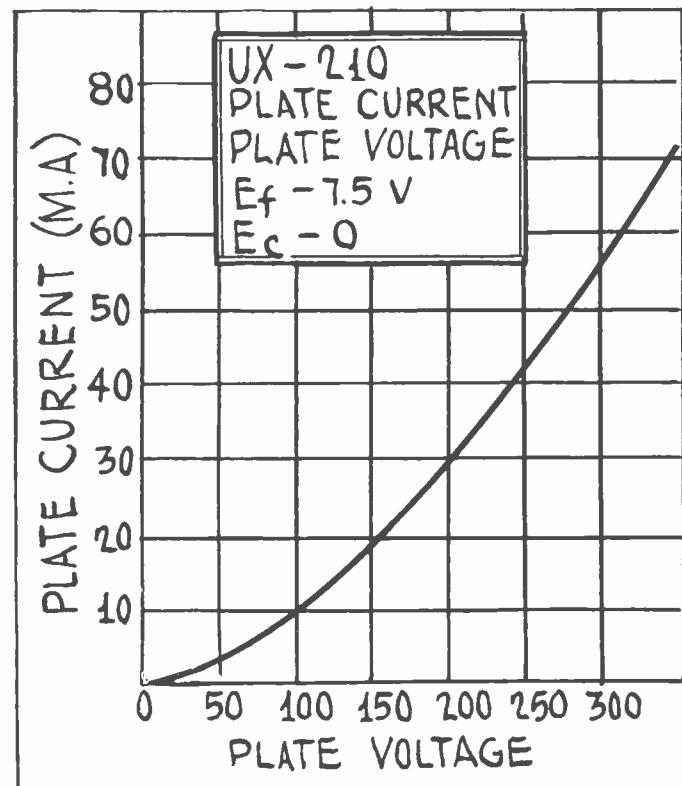


FIG. 85
A PLATE VOLTAGE, PLATE CURRENT CURVE FOR THE 210 POWER TUBE TAKEN WITH ZERO BIAS ON THE GRID

CHARACTERISTICS OF 210

Filament terminal voltage.....	7.5
Filament current, amperes.....	1.25
Plate voltage, maximum.....	425
Plate current, milliamperes.....	20
Grid bias, volts.....	35
Plate resistance, ohms.....	5,000
Mutual conductance, micromhos.....	1,500
Amplification factor	8
Maximum undistorted power, milliwatts.....	1,540
Maximum safe plate dissipation, watts.....	12 to 15
Grid-to-plate capacity, mmfd.....	8

PLATE CHARACTERISTICS OF 210

Plate voltage	Grid bias	Plate current	Mutual Con- undistorted		
			Plate resistance (ohms)	ductance (micromhos)	power (milliwatts)
180	12.0	7.0	7,000	1,100	145
250	18.0	12.0	5,600	1,330	340
350	27.0	16.0	5,150	1,550	925
425	35.0	20.0	5,000	1,500	1,540

Curves

In Fig. 85 is a curve showing the relation between the plate voltage and the plate current for the 210 at zero bias and 7.5 volts on the filament. At 350 volts the plate current is 70 milliamperes. This curve may be used for estimating the plate voltage when the plate current is known or the plate current when the plate voltage is known. By zero bias is meant in this case that the grid is connected to the mid-point of the filament transformer supplying the tube.

The 210 is practically obsolete as far as power amplification in radio receivers is concerned, having been superseded by the 245 and the 250 power tubes. For this reason no family of plate voltage, plate current curves of this tube will be included.

Applications of Tube

In Fig. 86 is a simple, Hartley type oscillator circuit, incorporating the 210 tube. The filament current is supplied by a 110/7.5 volt step-down transformer T and the plate voltage either by a battery or a B battery eliminator capable of maintaining 350 volts across the B terminals. A by-pass condenser of .01 mfd. is connected across these terminals to confine the high frequency current to the oscillator proper. If the leads

210 Power Tubes

Anderson

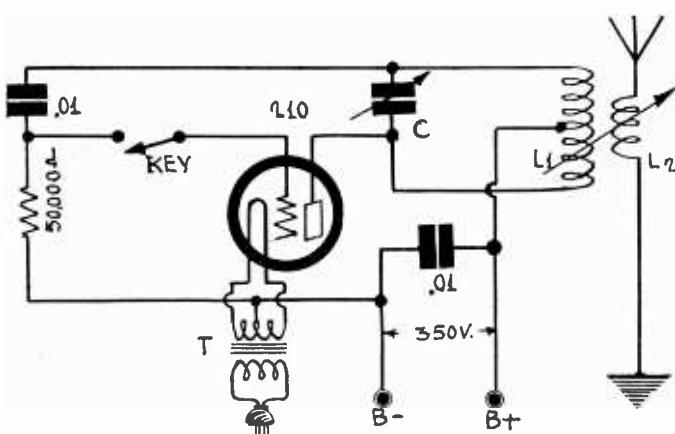


FIG. 86

A HARTLEY TYPE OSCILLATOR WITH A 210 POWER TUBE. A KEY IS PUT IN THE GRID LEAD FOR STOPPING AND STARTING OSCILLATION FOR SIGNALLING PURPOSES.

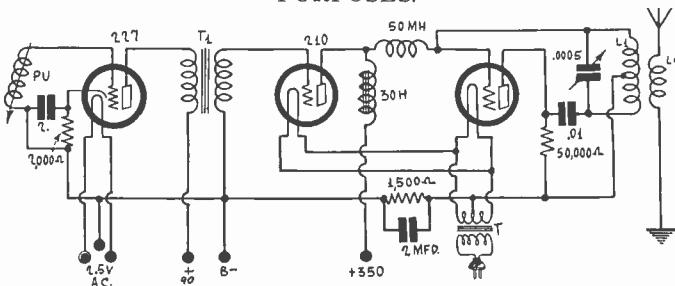


FIG. 87

A TRANSMITTING CIRCUIT INCORPORATING THE 210 TUBE USING A PHONOGRAPH PICK-UP TO SUPPLY THE TONE, A VOLTAGE AMPLIFIER, A HEISING MODULATOR AND A HARTLEY OSCILLATOR

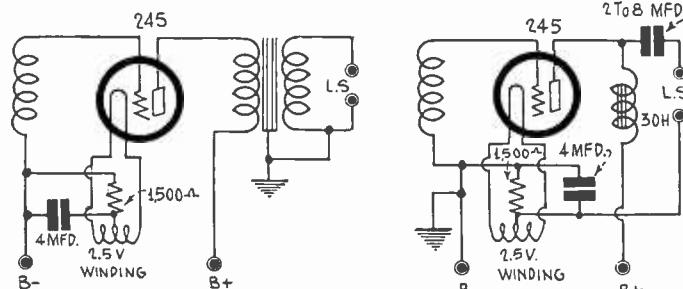


FIG. 88

TWO METHODS OF COUPLING THE LOUDSPEAKER TO THE 245 POWER TUBE. AT LEFT IS SHOWN THE METHOD OF CONNECTING AN OUTPUT TRANSFORMER AND AT RIGHT THE METHOD OF CONNECTING A CHOKE AND CONDENSER.

from the B battery eliminator are short this condenser is not necessary, because the filter condenser will serve the purpose. A stopping condenser of the same value is connected between the grid of the tube to the tuned circuit to isolate the grid from the plate voltage. A 50,000 ohm grid leak serves to maintain the grid at the proper potential. The tuned circuit, of course, depends on the frequency desired. For the broadcast band C might be a .0005 mfd. condenser and L1 a 160 microhenry coil.

Modulated Oscillator

The tap on the coil should be placed so that the ratio of the turns in the plate circuit to those in the grid circuit is about 0.8. The coil L2 should contain only a few turns of heavy wire and the coupling between the coils should be adjustable.

A key is put in the grid circuit for stopping and starting oscillation for signalling purposes.

In testing radio receivers it is convenient to have a source of modulated signal which is available at any time it may be needed and which may be adjusted to any desired frequency. For this purpose a circuit like that shown in Fig. 87 is suitable. It consists of a Hartley oscillator, a Heising modulator, a 227

audio frequency amplifier and a phonograph pick-up unit as the source of the tone.

The required condensers and resistors are given on the diagram but the inductances are left unspecified because different values and arrangements may be desired to meet specific conditions. For example, L1 may be a tapped loop designed for broadcast reception or it may be that a large solenoid coil may be desired, one designed for broadcast reception or for the reception of other radio signals. While an antenna coil is shown it is not always needed, because if a loop is used there will be enough radiation to receive the signal if the oscillator is in one part of the work room and the receiver in another, and that is all that is needed.

It should be remembered that the power radiation from a circuit like this is sufficient to cause interference in other receivers and that if the circuit is to be operated with full power a license is necessary. When L1 is a small coil and L2 forms a part of a closed circuit, there will be no appreciable radiation, yet it will be sufficient for testing purposes.

For broadcast receiver testing L1 may consist of a coil wound with 45 turns of No. 20 double cotton covered wire on a length of bakelite tubing 3 inches in diameter. L2 may be a coil consisting of a few turns of wire coupled loosely to L1 and connected to the input terminals of the receiver to be tested. The distance between the two coils can then be varied until the received signals have the desired value.

Transformer T1 is an ordinary audio frequency transformer. The 30 henry choke coil should be large enough to carry the plate currents of both 210 tubes, that is, it should have a current carrying capacity of about 50 milliamperes. There are many such coils available. The 50 millihenry RF choke should be wound with heavy enough wire to carry the current of one tube; that is, it should carry more than 16 milliamperes.

245

THE 245 is a power tube which, because of its favorable design and operating characteristics, is used more than any other power tube at the present time. Its filament terminal voltage is 2.5 volts, the same as that of the 227 detector-amplifier or the 224 screen grid tube. Hence it may be connected to the same filament winding as these tubes whenever this is desirable for design reasons. It has a maximum plate voltage rating of 250 volts and a grid bias rating at this plate voltage of 50 volts. Thus a voltage of 300 volts is required of the B supply. This is so low that relatively inexpensive condensers may be used for bypassing in the receiver and in the B supply, and it is lower than the maximum rating of electrolytic condensers, so that such condensers may be used when large capacities are needed. It has a maximum undistorted power rating equal to that of the 210 when 425 volts are used on the plate of this tube, and, therefore, the same power will be obtained with a lower voltage.

CHARACTERISTICS OF THE 245

Filament voltage (AC or DC).....	2.5
Filament current, amperes	1.5
Plate voltage, maximum.....	250.
Grid voltage (bias).....	50
Peak grid swing, volts.....	50
Plate current, milliamperes.....	32
Plate resistance, ohms.....	1,900
Mutual conductance, micromhos.....	1,850
Undistorted power output, milliwatts.....	1,600
Amplification factor	3.5
Overall length (inches)	5 5/8
Overall diameter (inches)	23/16
Socket.....	Standard UX

The tube may also be operated with 180 volts on the plate, when the maximum undistorted power output will be 780 milliwatts. When this voltage is used the grid bias should be 34.5 volts, and the plate current will be 25 milliamperes.

The grid bias values given above for this tube are for AC on the filament. When DC is used and when the grid is returned to the negative end of the filament, the bias should be 33 volts when the plate voltage is 180 volts and 48.5 volts when the plate voltage is 250 volts.

The output, which is 1,600 milliwatts, is sufficient to operate a large loudspeaker without resorting to push-pull, and its output impedance is such that it matches the impedance of most output transformers or speakers since it is practically the

(Continued on next page)

A Fine Power Amplifier

By Herman Bernard

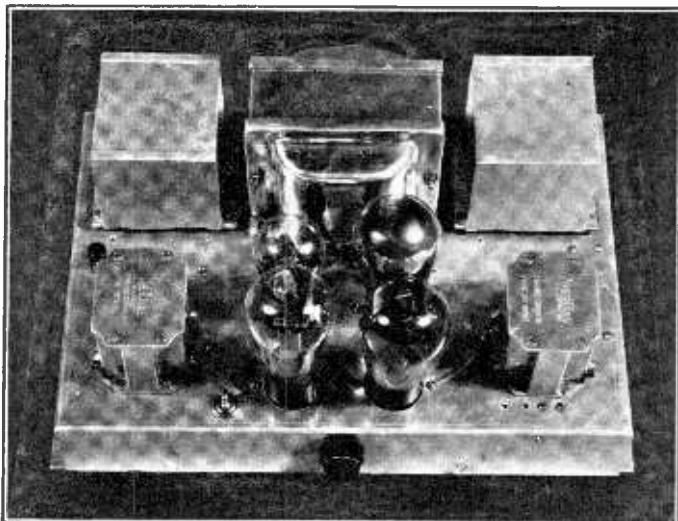


FIG. 1.
VIEW OF THE REAR OF THE POWER AMPLIFIER. IF A CENTER-TAPPED CHOKE IS USED IN THE B SUPPLY, PUT THE 1 MFD. CONDENSER NEXT TO THE RECTIFIER IN FIG. 2.

THE present popular form of push-pull power amplifier for AC operation is one that uses a single-sided first audio stage and a push-pull output, with transformer coupling in both stages. The output tubes that run in highest favor are 245s, while the first audio tube is a 227.

Fig. 1 shows the wired model of the power amplifier design depicted in Fig. 2. It is suggested that a four-tap switch be used for the detector voltage, so that the 45 volt tap may be used also. This switch takes a regulation knob, which is shown in front, in Fig. 1.

If a phonograph pickup connection is desired it may be included by putting the binding posts for the pickup between grid and ground of the first audio tube. It is preferable to include a switch between the "phono" grid side and the G connection of the audio transformer, so that when the switch is opened and the pickup is inserted, the audio transformer secondary is out of circuit. When the switch is closed and the pickup removed the transformer secondary is in circuit.

Uses Parallel Plate Feed

Parallel plate feed is used in the first audio tube to keep the direct current out of the primary of the push-pull input

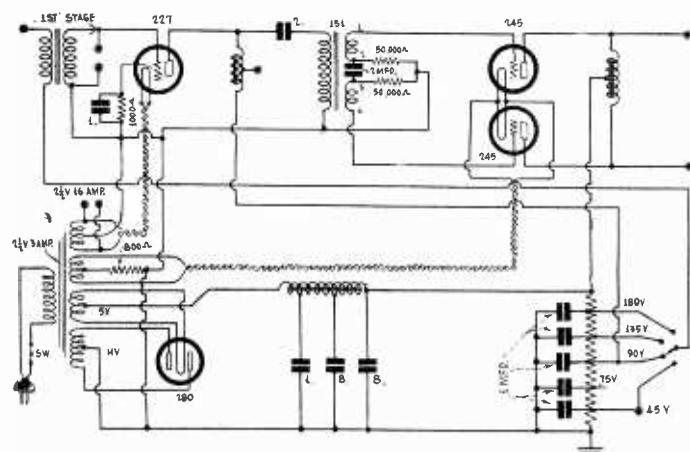


FIG. 2.
DESIGN OF AN AUDIO POWER AMPLIFIER, USING 245 PUSH-PULL OUTPUT. THE AUDIO TRANSFORMERS ARE AMERTRAN DE LUXE (FIRST STAGE) AND NO. 151 PUSH-PULL INPUT (SECOND STAGE). IF A CENTER-TAPPED CHOKE IS USED IN THE FIRST PLATE, IGNORE THE TAP.

transformer, as this current will be high, around 10 ma, and it is desired to maintain the primary inductance as high as possible, which the parallel plate feed system does.

The full reasons for this were set forth in the October 4th issue, in which the circuit shown in Fig. 2 was discussed theoretically, and contrasted with a slightly different circuit that gave results not nearly so good as those obtained from Fig. 2.

The size of the chassis is 14 inches long, 9½ inches, front to back, and 2¾ inches high. The reason for the height is that some of the parts are placed underneath, for instance the single choke in the first audio plate circuit, the voltage divider and by-pass and filter condensers.

Assortment of Plate Voltages

The power transformer used should be one that permits connection of 2½ volts AC to a tuner, to power the heaters of at least five more 227 or 224 tubes. Some such transformers have three 2½ volt windings, one for the push-pull pair, one for the single first audio tube, and the third for the tuner tubes.

The B supply of the power amplifier will furnish plate voltages for the tuner, and the use of a multi-tap voltage divider will permit of the choice of an assortment of voltages, although only six positive B voltages are shown.

The 245 and 210 Power Tubes

(Continued from preceding page)

same as the output impedances of the 171A and the 250 power tubes, for which most output transformers and speakers have been designed.

Mounting of Tube

The tube should always be mounted in a vertical position in a socket that makes firm contact so as to insure low contact resistance and to prevent any possible noises. Since the plate and filament currents are comparatively large a large amount of heat will be dissipated in the tube. Provision must be made for circulation of air to prevent overheating. If the tube is in the open there will be enough natural circulation, but if it is boxed up in a shield overheating will result unless holes are provided both above and below the tube. The heat generated by the tube will then provide the power necessary to maintain a cooling draught of air.

Since the filament current is 1.5 amperes, it is important that the leads from the 2.5 volt winding on the transformer to the filament be as short as practicable and that they be made of heavy wire, in order to reduce the voltage drop in the leads as far as possible. It takes only 1-6 of an ohm to cut the voltage from 2.5 to 2.25 volts. A resistance of this magnitude can easily be obtained in the leads if they are long and made of fine wire. When there are splices, the joints should be thoroughly cleaned, twisted together and soldered well.

When the filaments are heated with AC it is recommended

that the grid bias for the tubes be provided by a resistor placed plate return lead, or more specifically, between the mid-tap of the 2.5 volt winding and the B minus terminal of the B supply, the grid return being made to B minus. When the plate voltage is 250 volts the recommended value for the bias resistor is 1,550 ohms, which is obtained approximately when the grid bias of 50 volts is divided by the plate current of 32 milliamperes. When the plate voltage is 180 volts the recommended bias resistor is 1,350 ohms. These values, however, are not critical and a resistance of 1,500 ohms may be used in both cases.

In case the 2.5 volt winding serving the tube is not center-tapped, the bias resistor may be connected to a center-tapped resistance of from 20 to 40 ohms connected across the filament terminals on the socket, or near the socket. A resistor with an adjustable center-tap is desirable since it may permit the removal of some hum that may remain.

The bias resistor should always be shunted with a condenser of not less than 4 mfd. capacity, except when the amplifier stage is push-pull and accurately balanced. In that case the condenser may be omitted and the bias resistor should only be half as great as when one tube is used in the power stage. When two tubes are operated in parallel in the last stage, the bias resistor should also be one-half the value specified for a single tube, but in the case the by-pass condenser must not be omitted.

[The 250 tube will be discussed next week. Also more about the 245 will be printed then.—EDITOR.]

Loftin-White Voltages

By Neal Fitzalan

THE adjustment of Loftin-White type amplifiers sometimes gives the experimenter a good deal of trouble, yet when one of these circuits has been adjusted it usually stays in adjustment and continues to give excellent quality and service. Any time spent in getting it adjusted correctly is well spent.

The first requirements for such a circuit is that the total voltage shall be high enough, for if the voltage is not equal, approximately, to the sum of the voltages required for the plates of the two tubes involved the operation will be unsatisfactory. Hence to start with a voltage supply giving adequate voltage must be provided. This does not need to give a high current for the total current requirement is only slightly in excess of the requirement of the power amplifier. If the power tube is a 171A, as is the case in the circuit illustrated in Fig. 1 herewith, the current need not exceed 25 milliamperes, for that tube takes 20 milliamperes and the rest may be allotted to the voltage divider.

Tube Voltage Adjustments Vital

Having made provision for adequate voltage for the plates it is only necessary to adjust the circuit so that grid and screen voltages are correct. Now the grid voltage on the power tube is the drop in resistance R5 and is the product of the resistance in ohms and the current expressed in amperes. Suppose the resistance is 500,000 ohms. The required bias is 43 volts, 2.5 being allowed for the fact that the current in the filament is alternating. Thus if the drop is to be 43 volts the current through R5 must be 86 microamperes. If we can adjust the circuit of the 224 so that this plate current flows and so that the tube remains a good amplifier, we have solved the problem of adjustment.

The plate current of the 224, which is the current through R5, can be adjusted by varying the plate, screen and grid voltages on the tube. The applied plate voltage on this tube should be about 180 volts. This is the voltage drop in R2 and R3. Through these resistors the total current flows, except certain currents which are so small that we may neglect them without committing an appreciable error. Let us assume that the current is 25 milliamperes. Then the sum of R2 and R3 should be 7,200 ohms. We can make it 7,000 ohms without changing the voltage appreciably, and we select that because we can make it up from a 2,000 ohm potentiometer for R2 and a 5,000 ohm resistor for R3.

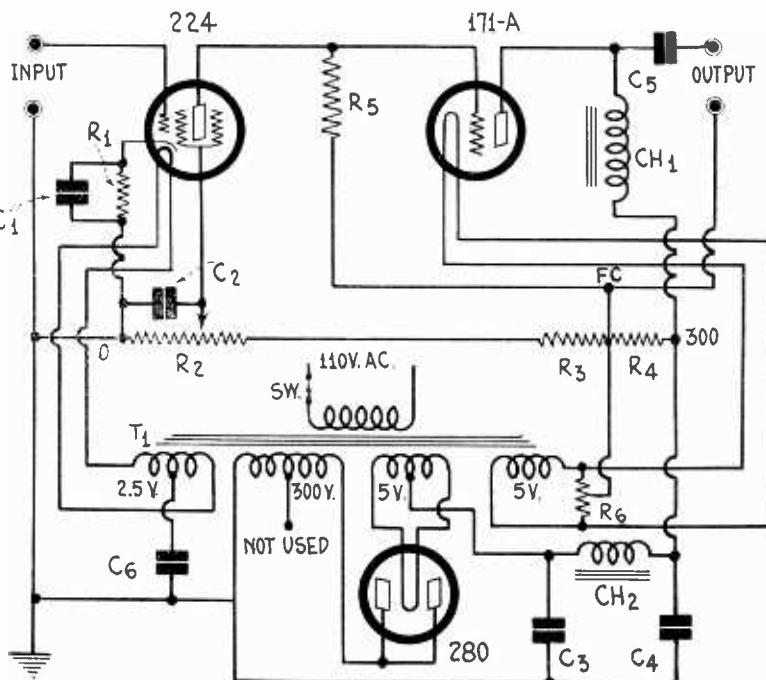
Adjustment of Grid Bias

When the applied plate voltage is 180 volts and the grid bias is 1.5 volts, the screen voltage on the 224 should not be higher than 15 volts. If we connect the screen lead to the slider of the potentiometer we can get any voltage we desire between the limits of the voltage drop in R2. The total drop in R2 will be 2/7 of 180 volts, or 51.5 volts. We can easily set the potentiometer so that the screen voltage has any desired value less than this. This adjustable feature in the circuit is highly important because even if the plate and grid voltages are not exactly right, it is possible to set the screen voltage so that the right combination results.

The grid bias for the 224 tube is obtained from R1 in the cathode lead of the tube. We desire a voltage drop of 1.5 volts and we have assumed the plate current to be 86 microamperes, or rather, we fixed this current when we chose the value of R5 and the grid bias on the power tube. We have to add the screen current to this to find the total current in R1. It is safe to assume that the screen current is 10 per cent. of the plate current. Hence we have a current of 94.6 microamperes. We can assume this to be 0.1 milliampere without making a great error. Therefore the value of R1 should be 150,000 ohms. In many circuits 50,000 or 100,000 ohms are used in this position. The circuit will work with any one of these three values provided that the screen voltage is set correctly, for a change in the resistance merely changes the bias, and that is not critical as long as we have a means of varying the screen voltage. The highest value suggested is likely to give greater stability to the circuit. One object of using the resistance drop method of getting the bias is to prevent drifting of the bias, or instability on the very low frequency, or on zero frequency.

The Voltage Supply

We now have adjusted the screen grid tube circuit, or have provided means for making an experimental adjustment. It remains to fix the value of R4, which determines the plate voltage on the power tube. We want the drop in this to be 180 volts, and since we have allowed 25 milliamperes and the power tube takes 20 milliamperes we have only 5 milliamperes left. Thus R4 should have a resistance of 180/0.005, or 36,000 ohms. A 50,000 ohm variable resistance is suggested because it permits another voltage adjustment which may be needed in particular cases.



THE DIAGRAM OF A LOFTIN-WHITE TYPE AMPLIFIER UTILIZING A 224 SCREEN GRID TUBE, A 171A AMPLIFIER, AND A 280 TUBE AS HALF-WAVE RECTIFIER.

A B supply circuit is included in the diagram of Fig. 1. It utilizes a 280 rectifier tube with its plates connected together. That is, it is a half wave rectifier. The object of this connection is to utilize the entire voltage of the transformer and thus get adequate rectified voltage for the two tubes. The voltage of the transformer is 600 volts, 300 on each side of the tap, which is not used. Only about 360 volts will be needed for the amplifier and the voltage output of the rectifier may be higher than that, but this presents no difficulty. It is all right if the voltages on the two tubes are higher than 180 volts. If there is an increase the grid voltages will be automatically adjusted to higher values. Moreover, it is quite permissible to increase the applied voltage on the screen grid tube. This is done by increasing the value of R3, say to 7,500 ohms. Any change that this will effect in the grid voltages may be offset by adjusting the screen voltage for which provision has been made.

A single choke coil Ch2 is used in the filter. Since the current is only 25 milliamperes the filtering problem is very simple and one choke is sufficient. There will be very little saturation effect in the coil and therefore the inductance will remain high. It is not necessary to use a low resistance choke coil. Indeed, it is not even desirable in this particular case since the voltage may be considerably higher than is needed. If the resistance is as high as 1,000 ohms the drop in the choke will be 25 volts, and this can easily be spared.

The two condensers C3 and C4 in the filter need not be higher in capacity than 1 mfd. and 2 mfd., respectively, but they should be designed to work on voltages of at least 1,000 volts.

The power transformer is provided with one 2.5-volt winding for the 224 and one 5-volt winding for the 171A. In one case the center-tap is connected to ground through a condenser C6. This condenser might be omitted and the mid-tap connected directly to ground.

By-pass Condensers in Amplifier

The condenser C1 across the bias resistor R1 need not be higher than 0.1 mfd. because it is connected across a high resistance, but it may have a value of 1 mfd. The value of C2 should be 1 mfd. or larger.

A 30-henry choke may be used for Ch1 and a condenser of from 2 to 4 mfd. for C5.

The resistance R6 across the 171A tube filament should have a value of from 30 to 40 ohms and it should be accurately center-tapped. A potentiometer with an adjustable tap is preferable to a fixed resistance with tap because it may be adjusted until the hum is minimum or zero.

After having connected up a circuit of this kind, it may not work right at first. This does not necessarily mean that an error has been committed in the wiring, but that a little adjustment of voltages is necessary. Means have been suggested

Hertz in 1887-1889 Trans.

By John C.

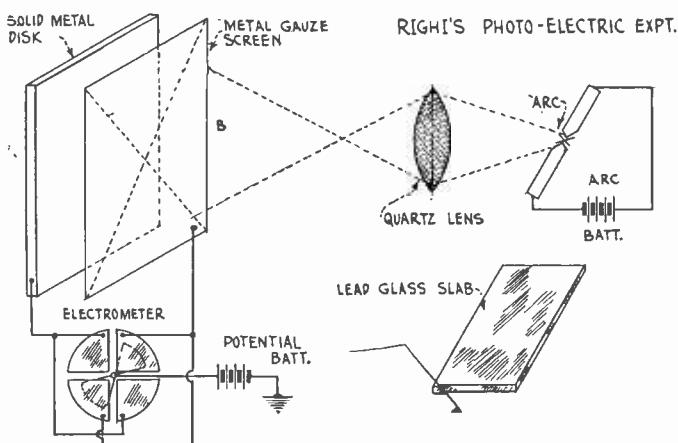


FIG. 1
THE FIRST PHOTO-ELECTRIC EXPERIMENT.

[This article is the second of a series dealing with the historic aspect of radio transmission and reception. The first article appeared last week in the October 11th issue, and was a condensed resume of important scientific steps that culminated with the successful commercial experiments of Guglielmo Marconi in the years 1899 to 1901.—EDITOR.]

ONE of the most interesting aspects of the study of the early development of the transmission and reception art is to be found in the perusal of records that deal with the methods contemplated or actually used by the Greeks at or around the time of the Fall of Troy. This is certainly a relatively early age in communication history, and it is perhaps difficult to trace many close parallels to modern practice, but, nevertheless, the thoughts and deductions of the early observers, if studied patiently, will reveal a remarkable consistency of effort toward the ultimate communications ideal—that of reducing the time taken to handle a message to the most practicable minimum. The date of the operation of the "first" telegraph probably antedated the time of Galileo's famous experiments with telescope and lanterns.

Dr. James Hooke, in "The Philosophical Magazine" for the year 1798-1799, describes the invention of a telegraphic system, and cites that the use of the "telegraphic" method of communication was known to the Greeks prior to the 16th century and that the news of the Fall of Troy was known at distant points long before it could have been carried by runners, and the use of a night and day telegraph was mentioned by Polybius, although there is no evidence that the apparatus used was to any great extent copied by originators of later systems.

An Esoteric Marquis

In 1663 the Marquis of Worcester, writing in his "Century of Inventions," claimed to have discovered a method by which a man could discourse without "prior notice" having been given, at a distance at which "the eye could discern black and white," and in the next sentence it is declared that communication could be maintained though the night was "black as pitch is black." This obviously leaves a lot to the imagination, but it is certain that there was a lot of thinking about the subject of the telegraph.

Dr. Hooke's "telegraph" is a system the details of which as described by him make very interesting reading, whether from the viewpoint of their interest to physics, or simply the enjoyment to be derived from reading them.

It would be unjust to the memory of Dr. Hooke in this connection if further attention were not paid to some details of the system which he invented, and which undoubtedly was used, although at present no specific record is available telling where an installation was in successful operation.

Numerals Designate Letters

Hooke's telegraph makes use of a series of telescopes so placed on promontories that in clear weather, and when the general conditions permit, and the observers stationed at the various posts agree by previous arrangement to be present, the transference of intelligence is relatively fast.

The transmission of a message does not involve the use of a code that is non-understandable to the observers at the inter-

mediate points, as did the system of an earlier Italian experimenter, Melloni, but used instead simple and complex numerals that corresponded to the letters of the alphabet, which were painted on hinged boards that were so arranged that they could be easily swung out into the line of vision of a distant telescope. The observer there, merely noting the series of displayed characters, would write the message down, and the same was repeated again via the duplicate set of signals.

It is to be noted that the likelihood of error developing in a message when en route was reduced by having the successive interposed observers write the message down. Furthermore that the places where the telescopes were mounted were selected with a view to having the service unaffected as far as possible by the prevailing weather conditions, and also that all necessary corrections for refraction should be made.

An interesting note in connection with the above is that the shape of the characters painted on the signal boards was experimented with for a long time, as it was found that the effects of atmospheric aberration made some shapes of characters more or less unreadable.

At this point we have to don the fabulous seven league boots, and journey over a period of 142 years, to the time when some of the more notable researches were in progress.

Righi Shows the Photo-Electric Effect

While Heinrich Hertz was a student under von Helmholtz, and then later was von Helmholtz's assistant, he began to develop interest in the new field of physics that was being sponsored in England and France, principally, although some work had been done in Italy of an experimental nature on the electromagnetic theory of Maxwell.

In his earlier studies Hertz was interested in the fact that he found differences in the conductive ability of portions of the visible spectrum by means of various experiments. Not long afterward three other young physicists working on related researches corroborated the findings of Hertz. The three others were Wiedmann, Ebert and Hallwachs. The confirmation of their observations, and also the explanation of some of the things that were not clear at the time, was explained later by Prof. A. Righi, whose experiment is illustrated in Fig. 1 which shows the disposition of the apparatus used.

Magnesium Preferred

The apparatus consists of two rectangular metallic conductors, one of which is solid and the other one is a screen of gauze through which light can shine easily. Below is seen an electrometer of the quadrant type, which may have a sensibility of 135 divisions to the volt (electrostatic). The vane is kept at a fixed potential by the earthed battery, directly below, although the connections shown are subject to change during the course of the experiment.

The source of light is preferably an arc maintained between carbon pencils, and directly below is the battery that operates it, and in between the light source and the two screens an optical system is placed that is represented here by the quartz lens. Below is a leaden-glass slab that is somewhat larger than the two metallic screens at the upper left, though it does not appear so in the sketch.

It may be noted here that although sunlight can be used, that it is much better to use magnesium, and the electric arc is better yet. The metallic gauze screen B is so mounted that it is held parallel to the solid plate A and is also insulated from it.

The diversity of light sources mentioned above is given because this is the historical order in which they were first used, and is also the ascending order of their ultra-violet light radiating capacity, a coincidence that is interesting.

Although the early records pertaining to the progress of the radio art do not trace the connection that was known to exist between electric wave propagation and visual light waves, the recent commercial experiments in which the photoelectric effect has figured, and the fact that Prof. Righi was able to throw much additional light on the early work of Hertz and his associates, are the reason for including a description of Righi's experiment here.

Same Final Potential

Referring to Fig. 1 again, if A be first earthed, and then connected as shown, and the two plates are exposed to the arc's rays, the deflection is negative, if A is zinc and B is brass. But if A is initially charged to a higher potential the final potential of the two plates is similar, and the effect on the final value of the charge on A made by altering the proximity of B, reaches the same potential.

The deflection of the electrometer needle measures the differ-

mitted on 4 and 5 Meters

Williams

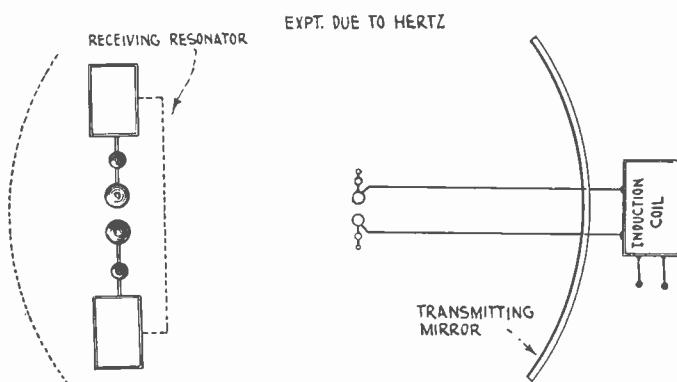


FIG. 2
ONE OF HERTZ'S SHORT-WAVE MIRROR TRANSMITTERS.

ence of contact potential between A and B, and if B is connected to the electrometer disks that A was formerly connected to, the deflection is still negative, showing that when two metals are in the path of a light beam, and one of them receives the incident illumination, the system acts like a voltaic cell, and may thus be called a photoelectric cell.

Four cells similar to the above were subsequently arranged by Righi, and were found to exhibit the same electrostatic phenomenon as when the plates of an ordinary battery are plunged into water.

And again, if the net or gauze plate of Fig. 1 be removed and the radiation from the arc light be allowed to fall on the solid plate A, after this plate has been earthed, and connection is made as previously, the electrometer deflection builds up very slowly, indicating, it seems, that the surrounding negatively charged particles in the air, and particularly those in the light beam, tend to migrate to the positively charged plate.

Prof. Righi also investigated the photoelectric possibilities of a brass plate that was coated with selenium, a combination that forms a photoelectric cell.

The glass plate of Fig. 1 when so placed as to intercept the beam of the arc, suspends the operation of the experiment, showing very effectively the stoppage of ultra-violet light by lead glass. The utilization of the light-sensitive mineral selenium as a coating material was doubtless found, on later experiment in connection with photoelectric work, to be effective, but this mineral likewise suffers a drop in ohmic resistance when visual light falls upon it, hence it does not exercise a pronounced selective effect. So this brief glimpse at events gives a slight idea of the great amount of work that was done to further the transmission art.

In this connection, the "History of the Doctrine of Radiant Energy," a monograph by Lord Rayleigh, reveals some interesting contrasts of reasoning that we may as well review briefly.

Early Views of the Theory of Light

Between 1800 and 1843 there were two schools of contemporary thought which acknowledged the mutually imposed challenge of proving beyond doubt the true nature of visual radiations. As the visible spectrum at that time had not been explored beyond its apparent upper or lower limits, we can begin to form an idea of the extent of the various controversies. Here the available records are as profuse as the ones dealing with the photoelectric effect are scant. These two main divisions were the adherents of the "calorific theory" (relating to heat) and the "undulatory theory" (relating to waves) of the manner in which visual light was radiated.

For reasons that are not fully apparent the work of Maxwell, of nearly a hundred years previously, had borne fruit very slowly, and the thoughts of many were influenced by persons whose reactions were due in large measure to the solely practical observations they made. A physicist named Melloni in 1843 wrote that "light is merely a series of calorific indications, sensible to the organs of sight." This may be said to represent the consensus of the one school, and this principle was also reasserted by J. W. Draper in 1872, a lapse of 68 years, but during this interval the influence of the latter school had been growing, according to Prof. Langley, and the work of several new scientists began to command attention, notably the work of Herschel.

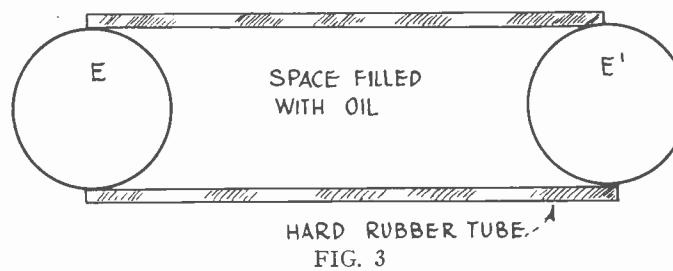


FIG. 3
RIGHT'S OSCILLATOR

The Herschel experiments showed that radiant heat consisted of parts that were differently refrangible, also that in general invisible heat is less refrangible than visible heat. There is no doubt that this conclusion was based on astronomical deductions, although the prismatic spectrum had been subject to theoretical analysis.

Substance or Quality

This difference in refrangibility can be shown in a variety of ways, via the spectroscope, and also under high dispersion, with a sensitive heat-detector in the area of the spectral lines.

Herschel did not cling to the views he first formulated.

The lectures of another physicist, Dr. John Young, yield the earliest information on formative theories, and Ritter of Berlin, and Dr. Wollaston at Cambridge both found that muriate of silver was blackened by "invisible" rays, which they said extend beyond the visible spectrum on the violet side, this being one of the first experiments that bore on the extension of the visible spectrum. They included that heat was not a substance but a quality, and that this "quality" must be in a motion.

In Newton's opinion heat was "minute vibratory motion of particles communicated through an apparent vacum" by a medium which was so concerned in the propagation of light, a view which though essentially sound did not receive the support it merited.

Herschel studied the relationship between the amount of heat radiated by various portions of the spectrum, as did Dr. Young, and believed that solar energy possessed three definite attributes, while Young stated that light differs from heat only in the frequency of its undulation. Here we may note the comparison with our modern physics. But Herschel finally decided that heat and light were two different kinds of radiation. Melloni demonstrated the diversity of solar radiation components by means of selective absorption.

The memoirs of Lord Rayleigh on the above give an excellent digest of the progress of various phases of the communications art, which will not admit of being condensed if its contents are to be informative. We will now have a look at the events of 1887-1889.

Hertz Experimented With Short Waves!

Doubtless it will prove something of a bombshell to some readers who have an idea that the advent of short waves is more or less modern, that Hertz showed that oscillation could and did give rise to electric waves in space, and developed means to intensify the phenomena on short waves by the use of mirrors. These consisted of polished metallic surfaces whose curvature could be altered.

The first attempts at transmission by use of these mirrors failed, due to the wrong ratio of radiator-gap and mirror curvature, but this was corrected and the first successful short-distance transmission took place on 4 and 5 meters. The mirrors that gave the successful results were concave ones, a detail that was not quite clear at first, as it had been worked out theoretically that a parabolic shape would have provided the most directional waves.

In addition long waves were used, but they were found not quite so good, although absorption effects were found not to be excessive.

The apparatus used for producing short waves, and long waves also, consists of a divided brass cylinder 3 centimeters in diameter, and 26 centimeters in length, being exactly divided in the center. Spark-ball surfaces are attached at the opposite centers, 4 centimeters in diameter, in hemispherical sectional halves. The conductors thus formed were a little over 13 centimeters long. The wave length of the oscillation was twice the length of either of the two halves of the straight-line conductor, this preliminary estimate being permissible for the state of the free vibrational period of an oscillation.

Construction of a Tube-

By Wads

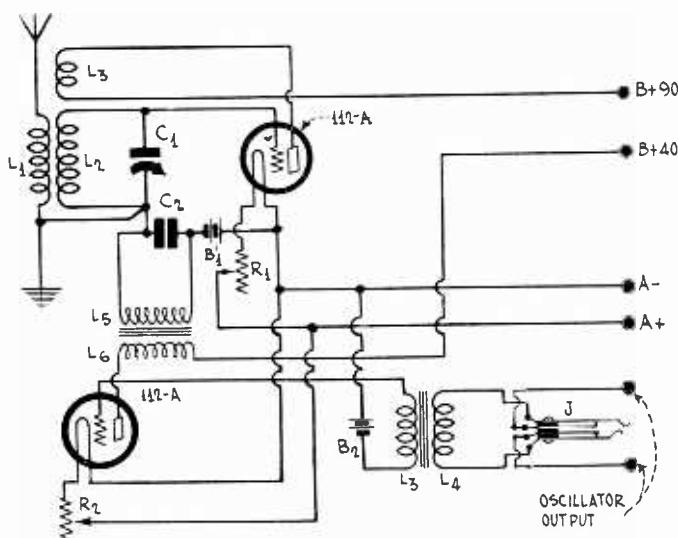


FIG. 1.
THE TUBE-OPERATED TUNING FORK.

[Preliminary data on the tube-operated tuning fork, with the circuit diagrams, were published last week, issue of October 11th.—EDITOR.]

MOST commercial forms of sustained vibration tuning forks that are not of the tube-operated variety use an exciter device of some kind, usually a carbon-grain microphone button which is attached to the fork at a point where it constitutes no very great additional load on the vibratory system. Some tube-operated forks also use this method of excitation, which with some refinements also acts as a kind of stabilizer, a scheme that is good where a very high order of precision is required.

But there is a way of obtaining an equally high order of precision of fork vibration which is not at all complicated and therefore commends itself to the radio fan who must combine economy with accuracy, and at the same time have a piece of apparatus that is sturdy.

This degree of constancy is obtained in large measure by the design of the magnetic circuit, on the parts of which are mounted the exciting and pickup coils.

There are seen to be two exciting coils, one in the plate circuit of the 224 tube, and the other in the control-grid circuit. The remaining two coils on the center arm are the pickup windings, in two parts, for the explicit purpose of enabling the operator to vary the output voltage or current, as may be required in the course of an experiment.

Laminations

The magnetic circuit is a laminated one and the material used is No. 10 gauge Swedish iron, of which there are several excellent grades on the market. The shape is that of a square letter C. The pieces of lamination-iron forming the letter are of the L shape, and the projections facing the tuning fork ends are the same thickness as the width of the face of the fork. You don't know what this measurement is until you have the particular fork that you intend to use, but if the desired frequency range is between the limits of 100 to 512 cycles, and the builder is actually going to use, say, ten forks distributed over this range, then you should have a core for each fork, but on the other hand if the range you desire to cover is limited to such easily obtained forks as 423, 440, 450, 512 or 523 cycles, in most cases you will find that any good musical instrument supply house carries these forks in stock regularly. The fork shown in the photograph cost 60 cents.

Exciting Coils Have Similar Impedance

The plate and grid coils have been assigned no dimensions yet, physically or electrically, because first the theory of operation of this device must be made clear, so that when assembly operations are begun the builder will know what it is all about.

In the case of the plate and grid coils the matter of phase relationship enters, a detail that does not complicate the assembly unduly.

When the fork is at rest there is a weak residual magnetic flux continually flowing in the fork arms, and in the soft iron core on which the coils are mounted, although there is no current flowing on these windings at all, and in fact the same thing is true directly assembly has taken place, and the soft

iron core has been mounted in the position shown in the drawing. This flux is frequently referred to as "terrestrial magnetism," and is not consequent upon previous excitation from the coils at all.

So considering everything at rest, so far as we have gone, let us see how the fork begins to vibrate.

Unstable Equilibrium

The mechanical vibratory system when there is no exciting current owing is one which is at rest, but when the exciting current begins to flow, the condition of stable equilibrium departs, and a condition of unstable equilibrium is substituted, whereby the initial increase of plate current in the plate coil results in the arm of the fork nearest to the plate coil core being attracted, imperceptibly at first, and just as imperceptibly the other arm moves toward the core on which the grid coil is mounted. These actions result in the generation of a minute voltage applied to the control-grid in such manner that the plate current is momentarily reduced, but the arm of the fork nearest the grid coil now recedes, causing the control grid to become slightly positively biased, which in turn results in a larger plate current flow than during the preceding cycle, and thus the vibrational amplitude of the fork is built up.

But this state of affairs does not continue indefinitely, because of the controlling factor of the fork's elasticity which causes the final amplitude of vibration to attain a constant value, despite the normal increase in plate current, which has progressively less to do with the state of frequency constancy than has the impedance of the two coils upon the limiting value of the pulsating component of the plate current. Some readers might suspect that perhaps the core saturates too, but there is very little likelihood of this, as the DC is of such low order, not more than 4 milliamperes.

The B Voltage Supply Circuit

The object of combining the power transformer, rectifier tube, filter circuit and voltage divider with the tube-operated fork is that it is desirable to have the transmitter assembly uncomplicated by wiring and parts whose presence would only mar the oscillator's performance. As there are three commercial AC supply frequencies, 25, 140 and 60 cycles, the power transformer used must of course be the correct one in this regard.

The power transformer should enable one to operate the fork and oscillator for several hours on end without excessive heating. The high-tension secondary winding excites the plates of a full-wave 280 rectifier tube, whose filament is supplied by a 5 volt, 2 ampere winding, while the high-current $2\frac{1}{2}$ volt winding supplies the heater current used in other parts of the apparatus. An extra $2\frac{1}{2}$ -volt winding (2 amperes) need not be used here.

The fan will notice that the leads from the voltage divider go directly to a terminal board on which are mounted binding posts and also that there are extensions from some of these that go to the fork circuit directly. The plate of the fork driving tube is supplied with not more than 180 volts, in fact 135 volts would be sufficient. The voltage divider that is to be used is one that has many more tap connections than the drawing would lead you to suspect, and therefore it will be very simple to locate the points that provide the designated plate voltages, which, it will be stated again, must always be measured at the plate of the tube in question.

Due to the particular circuit arrangement, by means of which the gradations of plate voltage are obtained, a uniform shunt current flows, and this "bleeder" current acts as a stabilizing influence, as its value is greatly in excess of that which flows in any one of the branch circuits, but is not of such value that it ever would tend to be conducive to overheating of the divider.

The parts are so spaced in the model that ample ventilation is assured, and also good accessibility is provided.

The Battery-operated Oscillator

One individual detail in connection with this model is that the use of the 112A tube is recommended. Here as formerly the tube is to be operated under standard conditions. The oscillator tube is shown with some grid bias value present, but not indicated. In 135 volts in the plate circuit the negative bias may be up to 9 volts.

Some years ago a battery model similar to Fig. 3 was made, but the 201A tube was used, and the grid was kept at zero, that is the grid return was connected to minus filament. The plate voltage found to provide the best average results was 90 volts.

The assembly is in no wise a radical departure from the AC model, as the only difference is in the fact that battery tubes are used. It has been found that the regular plug-in type coils

Driven Tuning Fork

worth Adams

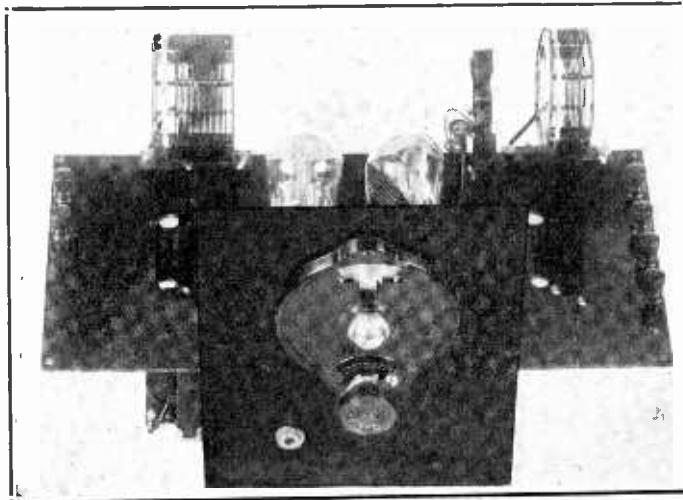


FIG. 2.
THE AC OPERATED OSCILLATOR

that are used in many of the circuits are suitable for the apparatus presented herewith.

Although not shown, a switch is to be provided so that the operator may change over to the broadcast coil quickly, this scheme avoiding the necessity of removing the one coil that you may be using. Also, the short-wave coil is provided with a movable tickler, an adjustment that is of considerable use in an oscillator of this character, as previously explained.

It is recommended that if you consider using a type of microphone different from the ordinary carbon-grain telephone transmitter, that you send its rating to the writer, but as there are many who will have the aforementioned type of microphone the one mentioned in the parts list will no doubt fill the bill nicely. The microphone is plugged in to the circuit with a filament-control, double-circuit jack, and a 4½ volt C battery is just right for operating it.

The tuning fork oscillator is used in many laboratories as a standard of frequency or as a source of pure tone of a sustained nature. It may be used for modulating a radio frequency wave without the use of a microphone since the vibrations exist in electrical form and may be impressed on the oscillator by means of an audio transformer or any of the other well-known coupling arrangements.

Mounting the Tuning Fork

The mounting of a tuning-fork is not a job that can be done in just any old way. It must be done carefully and with due respect for the vibrational characteristics of the fork, a matter which should be reviewed before the assembly is begun.

Tuning-forks have different periods of vibration that depend upon their mass and to a certain extent upon the length of the arms, but whatever the dimensions of the fork and its yoke, the manner in which it vibrates represents the behavior of all forks essentially.

The axis of oscillation of the arms is at right angles to the axis of the compressional pulse set up in the yoke, and as this compressional pulse is identified with the oscillatory motion, and in fact the movement of the arms is dependent upon the oscillatory motion, the secondary yoke mounting or bridge must be so attached that the mass of the fork is not altered in any way, that is, there is to be no drilling of holes. The only remaining method is to do a very careful job of soldering at a point on the yoke where there is no motion at all, a place that is called a node. Theoretically this nodal place is a point, but the extremity of the yoke is rounded and the error introduced by soldering to this is negligible and can be ignored.

The bridge is a piece of brass that comes already drilled, 3 inches long, 7/16 inches wide and of 1/16 inch stock, with mounting holes spaced 2 1/4 inches apart, that will take a 6/32 or 8/32 machine screw.

Tin the Mid-section

The mid-section of the bridge is to be tinned and the yoke extremity is to be treated the same way, then the two parts are to be united, care being taken to get the axis of the bridge at right angles to the axis of vibration of the fork, and finally to be careful to avoid the use of excess heat, and wipe the finished joint very clean with alcohol.

The parts list shows steel supporting bushings. These are to

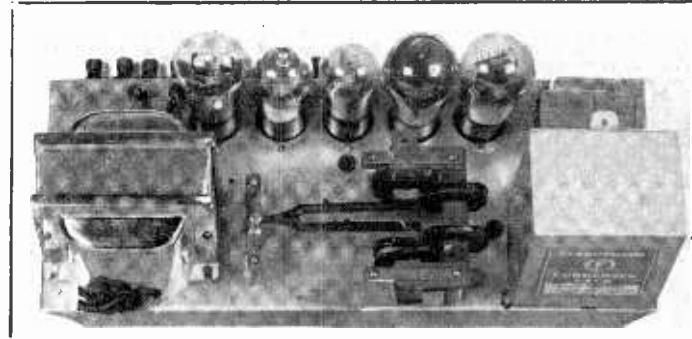


FIG. 3.
THE TUBE-OPERATED TUNING FORK.

be used to keep the fork in position firmly, and in the model shown four were used, two on each support-screw, 2 1/2 inches long, and passing down through the steel chassis which serves as a base. Only one of the brass pieces furnished is employed as a bridge support for the fork, and the threaded right-angled end of the brass strip is to be cut off. The remaining end is to be trimmed off neatly.

The magnetic circuit of this device is not unlike a letter E with the middle T-part missing, as a study of the picture will show, but the details of its construction will now be given.

The core is laminated, and the material is transformer-iron, or silicon-content iron, in strips that are 4 1/8 inches long by 11/16 inch wide, and of No. 14 gauge metal. There are two punched mounting holes, 3 7/16 inches apart, that will also take a 6/32 or 8/32 screw of 2 1/2 inches in length, and there are four of the steel supporting bushings used also, two on each support leg, as before.

Dimensions of E.

The overall dimensions of the E are, starting from the face of the plate-coil core that faces the fork, 21/16 inches to the external joint, then 2 1/16 inches along the external arm whose axis is parallel to the axis of the fork arms. Then the back of the E on which the output coils are mounted is 4 1/8 inches long, and the remaining parallel strip and the grid-coil core are of the same size as previously given for the plate-coil core, and the first named parallel strip.

The thickness of the core depends upon the core-window of the coil that you either buy or make, but in any case the coil has to slide over the core. In the model pictured herewith the coils used were loudspeaker magnetic unit type, which have a DC resistance of around 1,000 ohms.

If the reader desires to make his own coils, he will wind between 3,000 and 3,500 turns of No. 38 enamelled magnet wire around a coil-spool which you can easily make to slide over the above core. The spool ends may be of stiff cardboard, and rectangular section, 3/4 inch by 1 inch outside measurement, and spaced 1/4 inch wide for the plate and grid coils and spaced 1/2 inch wide for the output winding, which you may wind in two sections, as it will be found convenient to have a voltage adjustment, although there is no current drawn from this output coil.

1,000 to 1,500 Ohms DC Resistance

The ohmic resistance will be found to be 1,000 to 1,500 ohms, but in any case the turns or ohms of the plate and grid coil winding may deviate somewhat more without introducing error. Of course it's best to select a good grade of enamelled magnet wire so as to avoid all possibility of internal short circuits in the completed coil.

Ready-made coils may be ready before very long, but the use of these is not essential, though admittedly more convenient. The picture shows the layout of the parts that contribute to the formation of the B voltage supply system, and this together with the wiring schematics is felt to be self-explanatory, with perhaps the exception of the voltage-divider resistor, that is mounted underneath the chassis.

Extra Power Amplifier Included

It will no doubt be noted that there are three extra tubes on the tube operated tuning-fork assembly, and the explanation of their presence is that it was realized that they would in all probability be useful adjuncts, whether they are used in conjunction with the oscillator or not.

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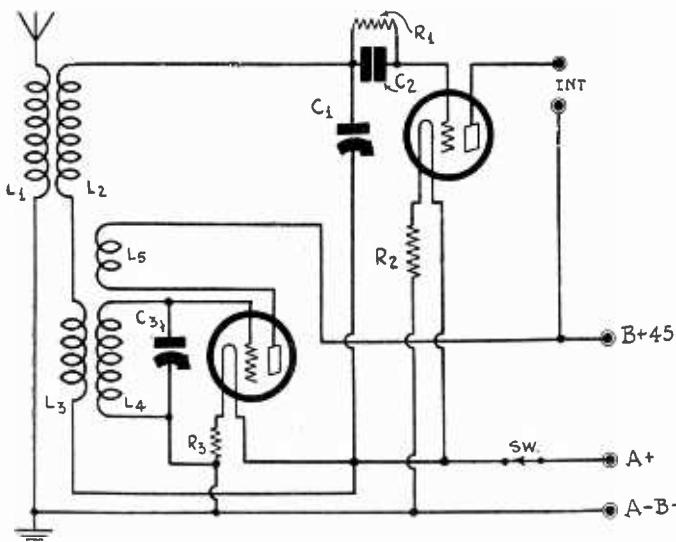


FIG. 856

THIS CIRCUIT ILLUSTRATES THE METHOD OF COUPLING THE OSCILLATOR OF A SHORT-WAVE CONVERTER TO THE GRID OF THE MODULATOR. THE PICK-UP COIL IS CONNECTED IN SERIES WITH THE SECONDARY OF THE RF INPUT TRANSFORMER

The Set Squeaks Like Crunching Snow

MY receiver has developed a peculiar type of noise the source of which I have been unable to locate. It sounds very much like the squeak occurring when some one walks in very cold snow. Can you suggest the cause of this noise?—W. C. K.

In nearly all cases this is due to a defective joint, and is due to tiny sparks across the layer of oxide or other non-conductor formed on the surfaces of the metal. Locate the defective joint, clean the wires thoroughly and then solder the joint. Defects like this may develop in the antenna circuit due to weathering of the joints which have not been soldered or in any part of the circuit where the conductors are exposed to acid. One common source is at the filament battery when this is of the lead-acid type. Still another cause of the trouble may be a run-down dry cell. It is likely to occur whether this battery is in the plate or the filament circuit. The cause is really the same whether it occurs in the battery or in corroded conductors.

* * *

Objection to Heaviside-Kennelly Layer

IF the Heaviside-Kennelly layer reflects radio waves, as it is supposed to do, and if light waves are the same in nature as radio waves, how is it that the layer does not reflect light coming from the sun and the stars? Is not this difficulty evidence against the theory that the layer exists?—A. P. C.

It would be evidence against the theory if radio waves of all frequencies were equally affected by the layer, no matter how high the frequency of a particular wave. But the fact is that as the wave length decreases the layer ceases to reflect. The very shortest radio waves that have been generated pass right through the layer and never return to earth. Now light waves are really extremely short radio waves coming from celestial bodies, and these waves pass through the layer. There is nothing unusual about this. Some bodies are transparent to red and opaque to violet. Red and violet differ only in wave length. Certain crystals will appear to be of one color when viewed by reflected light and to be of quite a different color when viewed by transmitted light. These crystals reflect some light and transmit other light. The difference between the reflected and transmitted light is only one of wave length.

* * *

A Bad Volume Control

DO you regard a high variable resistance across the secondary of an audio transformer a good volume control? If you do not think this a good scheme will you kindly suggest a better one?—T. N. G.

It is a very poor volume control because when the volume is turned down a heavy current flows in the secondary winding and this changes the quality. A much superior volume control is

a high resistance potentiometer across the secondary, connecting the grid of the tube following it to the slider. When this is done the load on the transformer does not change as the volume is changed because the total potentiometer resistance is across the secondary all the time. The slider merely enables one to take any portion of the total voltage across it and impress it on the grid. When this potentiometer is used it should be put across the secondary of the first audio transformer, that is, the one next to the detector. If there is resistance coupling here, the potentiometer can take the place of the grid leak and the scheme works just as well. A better way still of controlling the volume is to operate in the antenna circuit with the potentiometer.

* * *

The New Type Trimmer

IN your Oct. 11th issue you described the National Thrill Boxes and in the circuit diagrams there is a new type trimmer which consists of a coil with a variable condenser across it. Will you kindly explain in detail how this affects the tuning of the main circuit?—T. C. R.

If you put a piece of sheet metal against one end of a coil of a circuit which has been tuned to a particular frequency, the circuit is detuned. The reason is that there is a current induced in the metal sheet and this current opposes the inducing current in the coil. The effect is that the inductance of the coil is reduced. Likewise, if you put a turn of wire in the same position, or if you put it around the coil, the same effect occurs. The circuit is detuned because the inductance of the coils is reduced. Now if you couple another coil to the first coil, closing the terminals of the second, the same effect occurs, although not to the same extent. If you tune the second coil to the same frequency as the first coil, the effect is very great, and it is greater the closer the coupling between the two coils. The amount of detuning depends on the amount of current that is induced in the second coil, or turn, or sheet of metal, and the amount may be varied by varying the coupling or by varying the capacity in series with the second coil. In this new trimmer the variable condenser is connected in series with the coil and this coil is coupled loosely to the tuning coil. Therefore, when the condenser is turned there is a variation in the amount of detuning. Or if the first coil is not tuned exactly to the desired frequency it may be brought into tune by the trimmer condenser in series with the second coil.

* * *

Wave Trap in Plate Circuit

I RECALL that you have recommended the use of one by-pass condenser on each side of the radio frequency choke in the plate circuit of the detector, saying that if the second is not used the choke coil has practically no effect. Yet I have seen many circuits in which the secondary condenser has not been used, the latest being the National Thrill Box. Why do you recommend one thing and then let violations be published?—P. L. A.

What right have we to change the design of a receiver designed by others when our duty is to report it as it is? Radio engineers have different opinions about many things, and on this point they differ. At least they differ now; they may agree in a year from now. With respect to the Thrill Box, however, there is no discrepancy between what we have said and the design of the circuit. The coupling between the detector and the first amplifier is not entirely resistive for the plate impedance is an inductance coil. Now, this coil has considerable distributed capacity and that serves the purpose of the second condenser. While this capacity is very small, only a very small capacity is needed since the circuit is designed to work on very high frequencies. If the plate coupling impedance had been a pure resistance just like the grid leak, it would have been desirable to have connected a condenser of about .00025 mfd. across the resistance.

* * *

Minimum Capacity Permissible

YOU have frequently stated that there must be a definite ratio between the capacity change possible in a tuned circuit and the minimum capacity in the same circuit if the broadcast band is to be covered. Will you kindly explain how this ratio is obtained? Is the ratio the same for the oscillator in a superheterodyne as for the radio frequency tuners in the same circuit?—W. P. T.

If the minimum capacity in the circuit is C_0 and the possible capacity change is C , then the maximum possible capacity in the circuit is $C_0 + C$. Now if the tuner is to cover a range of frequencies from F_1 to F_2 , F_1 being the lower frequency, then the following relation must hold among the capacities and the frequencies: $C/(C_0 + C) = (F_1/F_2)^2$.

This equation is derived from the equation connecting frequency, capacity, and inductance. Two such equations are set up, one for F_1 and the other for F_2 , and then one is divided by the other. It is clear from the equation that the ratio of the minimum to the

maximum capacity in the tuned circuit depends directly on the ratio of the frequencies at the ends of the band to be covered by the tuner, since the ratio of the two capacities is equal to the square of the frequency ratio.

Now let us assume that F1 is 550 kc, the lowest frequency in the broadcast band, and that F2 is 1,500 kc, the highest frequency in that band. Then we have $(550/1,500)^2$, or what is the same thing, 121/900. This must be equal to the ratio of the minimum to the maximum capacity in the tuned circuit. If we now have a tuning condenser which can be varied by 500 mmfd. we can put in this value for C and determine Co, that is, the minimum capacity in the circuit. Putting in the values and solving the equation we get 77.6 mmfd. If the minimum capacity in the circuit is less than this the circuit will tune to a higher frequency than 1,500 kc. and if it is larger the broadcast band will not be covered.

If we substitute 350 mmfd. for C in the formula and solve for Co we get 53.7 mmfd. for the minimum capacity. In many circuits it is not possible to get a minimum as small as 53.7 mmfd. and therefore it is not often possible to cover the broadcast band with a 350 mmfd. condenser.

In the oscillator of the superheterodyne the frequency ratio may be the same as in the RF tuner but if the dials are to read about the same the ratios will not be the same. For example, if the intermediate frequency is 100 kc the lowest frequency will be 650 kc and the highest 1,600 kc. The ratio of these is 13/32, which is larger than the ratio of 11/30.

* * *

Common Sources of Hum

WILL you please list a few of the more common sources of hum in a radio receiver that is completely electrified?—B. F. L.

Some of them are: residual hum in the plate voltage from the rectifier and filter, hum from lack of balance of the filament and heater circuits, hum due to induction between the power transformer and the audio transformers or between the AC leads of the power supply and the grid and plate leads of the amplifier and the detector. Thus to eliminate hum it is necessary to filter the B supply thoroughly, to balance the filament and heater circuits, and to shield well against induction. We might add that the transformers and chokes should be placed so that induction is minimized because ordinary shielding is not effective at 60 and 120 cycles.

* * *

Modulation in Short-Wave Converter

YOU have shown two methods of impressing the local oscillation in a short-wave converter. In one the oscillation is impressed on the grid circuit of the modulator tube and in the other on the screen circuit. Which of these two methods is the better?—W. H. J.

There is little to choose when the advantages and disadvantages of both methods are considered. The grid circuit method may give a slightly higher sensitivity but it is necessary to make the coupling looser so that the RF tuned circuit will not stop oscillation by the wave-trap effect. The screen grid circuit method introduces a loss in the oscillator circuit because screen current flows, and this may also stop oscillation if the coupling between the pick-up coil and the oscillator is too close. Very good results have been obtained by both methods.

* * *

Lack of Voltage in Eliminator

IHAVE a B supply which gave good service for over two years. Then suddenly something happened to it and now I cannot get more than about one half the rated voltage. What could account for this?—L. A. W.

There are many things that could have happened. First, it may be that the rectifier tube has "played out." A new tube should fix this. Second, it may be that a short circuit has developed which causes a greater drain on the tube. This short may be in the receiver or in the B supply. Very likely, it is a condenser that has punctured. Another possibility is that a grid bias resistor has become short-circuited causing a heavy drain on the B supply because the bias is zero. This should show up when measuring the plate current. There is no way of determining where the trouble lies except experimenting. Proceed by elimination. It is always possible to divide the circuit so that the trouble will be in one or the other of the two parts. If one part is found all right the other part should be studied by elimination.

* * *

Optimum Values of By-Pass Condensers

WHAT are the best values of by-pass condensers in a B supply? Many B supply units have been devised but it seems that no two use the same values of by-pass condensers.—S. G. P.

The reason why no two B supply units use the same values is that there is no optimum value for any condenser. The choice of capacities is based on many factors, first, cost, second performance, third, space considerations, fourth, type of receiver the B supply is to serve. The larger the capacities are the better because the more thorough will be the filtering and the less will be the coupling effect of the B supply among the amplifier tubes. There is only one exception, and that is the condenser nearest the rectifier tube. It need not be larger than 2 mfd. and it should not be larger than 4 mfd.

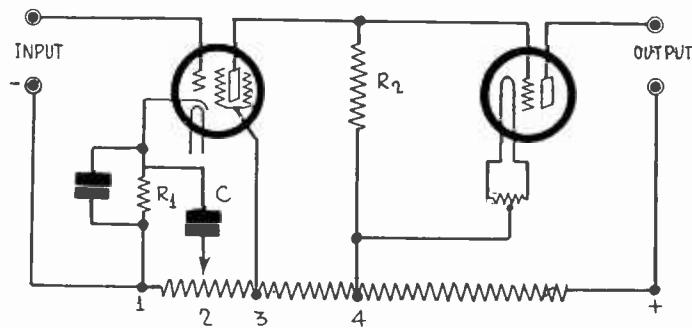


FIG. 857

THE CIRCUIT OF A LOFTIN-WHITE TYPE AMPLIFIER INCORPORATING A 224 AND A 245.

Loftin-White Type Amplifier

PLEASE show a diagram of a Loftin-White type amplifier utilizing one 224 screen grid tube and one 245 power tube and give some of the values necessary.

Fig. 857 is a diagram of a receiver similar to the Loftin-White. Exact values of the resistances cannot be given because they depend somewhat on the tubes used and the final adjustment must be made experimentally. However, the following values are approximately correct: R1, 50,000 ohms; R2, 0.5 megohm; resistance (1) to (3), 400 ohms in the form of a potentiometer; resistance (3) to (4), 5,000 ohms; resistance (4) to (+), 50,000 ohms. Condenser C should be 0.1 mfd. and the other condenser one megohm. The low resistance potentiometer across the 245 filament need not be higher than 20 ohms, but it should be accurately center-tapped. The slider on the 400 ohm potentiometer should be put where the hum is least. In adjusting the circuit two things should be watched carefully, namely, the bias on the 245, which is the drop in R2, and the screen voltage on the 224. The bias on the last tube should be 50 volts and may be assumed to be correct when the plate current in the output tube is 32 milliamperes. It may be varied by varying the resistance between (3) and (4), by varying the screen voltage, that is, the resistance between (1) and (2), or by varying R1. The total voltage required between (+) and (-) is 450 volts, although the circuit will work on somewhat less.

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COLUMBIA ASKS LICENSE TO TRY OUT TELEVISION

Washington.

The Columbia Broadcasting System is planning to enter the field of experimental television so it may be prepared to bring competition into visual radio "when and if the broadcasting of pictures may become as widespread and practical as the present network broadcasting of sound," according to Harry C. Butcher, director of the Washington office of the Columbia Broadcasting System. He so stated before the Federal Radio Commission.

Mr. Butcher, who appeared before the Commission in behalf of the application of the Atlantic Broadcasting Corporation, a Columbia subsidiary, for a new experimental television station in New York City, that the Columbia System was ideally qualified for this experimentation, emphasizing the importance of the connection of the Paramount-Publix Corporation, which owns one-half interest in Columbia.

Would Join Two Great Industries

"The prominence of the Paramount-Publix Corporation in the moving picture field is recognized," he declared. "Well-known actors and actresses, as well as stage effects and furnishings of Paramount-Publix Corporation, will be available for the experimental use of the applicant. Thus, two great entertainment industries, the moving picture industry and the radio broadcasting industry, will be brought closer together for practical development of television."

After technical witnesses for Columbia had testified that television transmitting and receiving equipment is made by the Radio-Victor Corporation, Gerald C. Gross, engineer for the Commission, declared that there would be duplication of experimental work, since the National Broadcasting Company is now engaged in television work in the New York area with RCA equipment.

Ready to Use the Best

He said that duplication would, in his opinion, be ill-advised, since there are only four channels available for television experimentation.

M. A. Trainer, television engineer of the RCA-Victor Corporation, who had been detailed to install the television equipment for Columbia if the application is granted, said that the apparatus to be used "complies with the highest standards now observed in the art, and has practically exhausted the immediately possibilities of laboratory development." He said that his company had developed pick-up and transmitting equipment which is capable of broadcasting a "very satisfactory picture." At present the picture is composed of 4,320 elements with a scanning 60 lines per frame and width equivalent to 72 scanning lines.

WISJ LOSES INJUNCTION SUIT

Washington.

A temporary restraining order, preventing the Federal Radio Commission from assigning WISJ, Madison, Wisc., to the 7801 kilocycle channel, was dissolved by the Supreme Court of the District of Columbia.

Bankrupt Stations to Lose Licenses

Washington.

If a station becomes insolvent it will lose its license, under the terms of a new order (General Order No. 95) of the Federal Radio Commission. Appointment of a receiver will be *prima facie* evidence of insolvency.

The part of the order covering this follows:

"That the insolvency of the licensee of any radio station shall be ground for the revocation of the station license and/or the refusal of the renewal thereof. The appointment of receivers upon grounds of insolvency and preliminary adjudications of bankruptcy will be considered by the Commission as *prima facie* proof of insolvency. Final adjudications will be accepted as conclusive."

LATEST BEACON USES RF AND AF

The seventh Great Lakes lighthouse station inaugurated Sept. 29 the sending of a new type of signal, by means of which ships may determine their distance from the sending station. These new signals are a part of the extensive radiobeacon system which the Lighthouse Service has developed not only upon the lakes but upon both coasts of the United States. The seven light stations which are now equipped to send out the new signals have both radiobeacon sending sets and the usual air or electrically operated sirens.

The development of the new signals has consisted of perfecting a device which permits the sounding of both radio and audible signals at the same instant. As radio waves are received instantaneously and sound waves travel at a definite known rate, the navigator can determine his distance from one of the lighthouse sending stations by noting the time elapsing between the reception of the radio signal and the audible signal.

This synchronization, as it is called, of radio and sound signals, is an important step in the development of ship protection, especially in time of fog. Within the last few years vessels suitably equipped have been able to take radio bearings on lighthouse sending stations, learning thereby the exact direction of which their ship lay in relation to the lighthouse. When only one station was heard, the only method of determining distance was by means of bow and beam bearings upon the same station as the vessel proceeded. Now the new signals offer an additional means of obtaining distance, and require no knowledge of high mathematics.

ROXY MAKES A CHANGE

S. L. Rothafel, director of the Roxy Theatre, New York, who left for an extended vacation in Europe, on his return will no longer be connected with the active management of the institution that bears his name, but will instead be in charge of the initial development of the new Rockefeller Radio Center, the plans of which were made public some time ago.

SIGNAL IS USED FOR TELEVISION SYNCHRONISM

Although only recently emerged from the secrecy of the research laboratory, radio television or radiovision now frankly bids for a place in the living room, alongside the usual sound broadcast set. Utmost simplicity of operation, self-contained equipment, compact dimensions, and socket-power operation, make for the attractiveness of radiovision, now that regular programs are on the air in many localities.

Studying the problems of radiovision reception in the home, engineers have endeavored to provide equipment for the lay operator. Therefore automatic synchronizing means have been introduced, so that the scanning mechanism of the receiver remains in automatic step with that of the transmitter. Instead of depending on an AC power system common to both receiver and transmitter, which would greatly limit the area served by any television station, engineers have developed a synchronizing method based on the signals themselves.

TRF Is Used

Again, instead of a short-wave regenerative receiver, the engineers have developed a simple non-regenerative receiver, especially designed for radiovision work, operated on the usual AC supply.

The latest radiovisor carries a large magnifying lens, which, in combination with another lens inside the deep shadowbox, permits of showing the pictures to several persons at a time. Below the lens is the switch panel, with one switch to start and stop the motor, and the other to switch from pictures to loudspeaker, in following the radiovision program.

A 60-cycle eddy current motor supplies most of the power to drive the radiovisor scanning disc. The synchronizer is used to keep the disc in perfect step with the distant transmitter, applying the slight acceleration or braking, as the case may be.

Lamp With Small Plate

This device is a phonic motor, operating on the strong 720-cycle (48 x 15) scanning frequency present in the usual 48-line, 15-pictures-per-second radiovision signal. It comprises a toothed rotor on the drive shaft of the radiovisor, together with an electromagnet or field coil furnished with 720-cycle energy by means of an extra amplifier in the radiovision receiver. This signal component is filtered out, amplified and fed to the phonic motor field.

Instead of a large plate lamp, as in previous models, the new Jenkins radiovisor employs a lamp with a small plate, which permits of considerable enlargement of images without loss of brilliancy or contrast.

NEW INCORPORATIONS.

School Radio Corporation of America, Wilmington, Del., radios—Corporation Service Co.

Gary Radio Shoppe—Atty. C. H. Ludder, Flushing, New York, N. Y.

Davaphone, Inc., New York, N. Y., sound recording devices—Corporation Trust Co., Dover, Del.

Radio Men's Association of New York—Atty. R. S. Ornstein, 454 West 151st St., New York, N. Y.

Spring Electric and Radio Co.—Atty. H. Strizver, 38 Park Row, New York, N. Y.

TRADE FAVORS HIGH POWER IN NOTE TO BOARD

The Federal Radio Commission has been urged by the Radio Manufacturers' Association, comprising virtually all prominent manufacturers of radio products, to increase the number of high-powered broadcast stations on cleared channels, in the interest of better broadcasting for the radio public.

Declaring that the public is best served by the high-class radio presentations of the chains and larger broadcast stations, President Morris Metcalf of the association has sent a letter to the Radio Commission urging an increase in the number of cleared broadcast channels and use of high power by more stations.

Approved by Director

The broadcast policies recommended to the Commission were approved at the annual meeting of the association's board of directors in New York.

The RMA Board also endorsed the plan, proposed in a Senate Resolution, to transfer the Department of Commerce Radio Division and radio activities to the jurisdiction of the Federal Radio Commission, pending final disposition of legislation to establish a federal communications body.

Legislation to protect the interests of radio manufacturers and broadcasters in pending copyright royalty legislation also was recommended by the Board of Directors.

Wants Some Stations Deleted

The letter of President Metcalf to the Commission, giving the manufacturers' views on chain and high-powered broadcasting set forth:

"Our Board of Directors is on record as favoring 'the deletion of stations not performing a real service to the public' and recognizes the overcrowded condition of the air as an evil which it is hoped the Commission will remedy.

"Of course we have no interest in the particular applications of any station or stations in connection with higher power on cleared channels and are content to rely upon the Commission's judgment in fixing the number of high-powered stations and the power to be used by such stations on cleared channels. We are vitally concerned, however, in chain broadcasting, in its maintenance, development and expansion, believing that the public is best served by the high-class radio presentations of the chain companies and larger broadcast stations."

A THOUGHT FOR THE WEEK

PRESIDENT HOOVER tells us he does not agree with the pessimists who declare that lowering the present standard of living in this country will right the economic situation. He believes we should strive constantly to improve our living standards because happy people mean a successful nation. So if you want a new radio set because your present one is outmoded, go out and buy it and help the radio business to land squarely on both feet. We don't hear the radio trade emitting any shrieks of protest over this idea.

New Short-Wave Hours for WGY

WGY announced a revision in the schedule of its short-wave stations, W2XAD and W2XAF, to improve the service during the Fall and Winter.

The new schedule, now in effect, provides for the operation of W2XAF on 9,530 kilocycles (31.48 meters) daily from 5:30 p. m. to 11:00 p. m., eastern standard time. This transmitter uses the doublet antenna.

W2XAD, 15,340 kilocycles (19.56 meters) will operate daily except Saturday from 1 p. m., to 3 p. m. Any special news broadcasters will also be carried Saturday afternoons when available to the transmitter W2XAD, which is essentially a daytime transmitter and will use an antenna directive on Europe.

BELLOWS WANTS 40 GIVEN 50 KW

Washington.

Henry A. Bellows, formerly a member of the Federal Radio Commission, told the Commission's examiner at a hearing that there was no good reason why all forty clear-channel stations should not be granted 50,000 watts. Mr. Bellows is director of WCCO, Minneapolis, which is seeking 50,000 watts. He is also vice-president of the Columbia Broadcasting System, which owns a one-third interest in WCCO. The Washburn-Crosby Company owns two-thirds.

Mr. Bellows said his view is shared "by virtually all radio engineers."

There are eight applicants from the South (Middle Western) Zone seeking 50,000 watts, and only two channels to allot at this power, under the Commission's rule of four to a zone. There are forty clear channels, the board limits 50 kw to twenty of these, and there are five equi-sharing zones.

"Radio to most city listeners is simply another form of entertainment," said Mr. Bellows. "To rural residents, however, it is a necessity of life."

Approximately 2,000,000 people are afforded "reasonably satisfactory service" by WCCO, with its present 7,500-watt output, Mr. Bellows declared. "With 50,000 watts power we hope to serve between 4,000,000 and 5,000,000," he testified.

RMA Will Manage Own Trade Show

Announcement is made by President Morris Metcalf of the Radio Manufacturers Association of the appointment of Major Harry P. Disbecker of New York as show manager of the RMA with headquarters in the RMA office in New York.

The appointment of Major Disbecker is pursuant to the policy adopted by the RMA Board of Directors to assume the complete management of the annual RMA trade show. Major Disbecker also will act as assistant to Bond Geddes, executive vice president of the RMA, and as show manager will have active direction of the RMA trade show through the Association's Show Committee.

2 STATIONS IN MEMPHIS WAGE A POWER FIGHT

Washington. A lively contest between two midwestern broadcasting stations was a feature of a long list of petitions for 50,000 watt rating heard by the chief examiner of the Federal Radio Commission.

WREC and WMC, Memphis, Tenn., "regional" stations, were the stations.

The Memphis stations asked the right to have improved positions in broadcasting. George Norris, vice-president of the Memphis "Commercial Appeal's" operating station, WMC, emphasized WMC's prior advent into broadcasting, its "superior service and stronger financial position" as factors which should be considered. WMC, he declared, has been broadcasting since January, 1923, whereas WREC began operating in 1926.

Not an Assailant

"I do not want to appear in the attitude of assailing any of the applicants or resisting their efforts to get mere power," said Mr. Norris, "but we have been broadcasting for a long time, and we feel that we should have an opportunity to show that our station sometimes gives better service, from a quality standpoint, than some stations with 10 times its power."

A report of Federal Radio Supervisor W. Van Nostrand, stationed at Atlanta, that WREC had operated in excess of its licensed power of 1,000 watts day and 500 watts night was introduced in the record. George O. Sutton, counsel for WREC, objected, but Chief Examiner Ellis A. Yost, president, held it was admissible.

\$40,000 to Rebuild

H. B. Wooten, manager of WREC, was questioned as to the technical and financial responsibility of the station. He said, according to "The United States Daily," that the transmitter of WREC represents an original investment of \$8,500, and that it was recently consolidated with another station transmitter. This could be rebuilt to 50,000 watts, he declared, at a cost of \$40,000.

The two Memphis stations, under Commission rules, were obliged to apply for a cleared channel assigned the third zone for the high power. They now operate on channels with low power, thus permitting the duplication of station assignments, whereas high power necessitates a cleared channel for good service.

Schedule of KDKA's Far North Programs

At about 11 p.m. Eastern standard time, on the following nights, KDKA, Pittsburgh, Pa., will begin broadcasts to those residing in the Far North. Late listeners have enjoyed these entertainments and message programs, now in their eighth year.

The schedule follows:

1930

October.....18th, 25th
November.....1st, 8th, 15th, 22nd, 29th
December.....6th, 13th, 20th, 25th, 27th

1931

January....1st, 3rd, 10th, 17th, 24th, 31st
February7th, 14th

Stations in United States and Canada, Corre

*Star before Call Letter denotes new station.
Star before Station Frequency denotes new frequency*

Star before Station Frequency denotes new frequency							
CANADA	kc	Station	kc	Station	kc	Station	kc
CFAC	690	WBAK	1430	WFDW	1420	WPSL	1230
CFBO	890	WBAL	1060	WIFI	560	WPTF	680
CFCA	840	WBAP	800	WFIIW	940	WQAM	560
CFCF	1030	WBAX	1210	WFKC	1450	WQAN	880
CFCH	600	WBBC	1400	WFKD	1310	WQAO	1010
CFCN	690	WBBL	1210	WFIA	1480	WPAP	1010
CFCO	1210	WBBM	770	WFIA	620	WPBC	1360
CFCR	960	WJB	770	WSUN	620	WQDM	1370
CFCT	630	WBBR	1300	WGAL	1310	*WODV	1500
CFCY	960	*WBBS	1370	WGBC	1210	KFMX	1250
CFJC	1120	WBBY	1200	WGES	1430	KFNF	890
CFLC	1010	WBBZ	1200	WGHP	630	KFOR	1210
CFNB	1210	WBCM	1410	WGBI	880	KFOX	1250
CFQC	910	WBMS	1450	WGBS	600	KFPL	1310
CFRB	960	WBNY	1350	WGCM	1210	KFLX	1370
CFRC	930	WBOW	1310	WGCP	1250	KFPN	1340
CHCA	690	WBRC	930	WGES	1360	KFQD	1230
CHCK	960	WBRE	1310	WGH	1310	KFQU	1420
CHCS	880	WBSO	920	WGL	1240	KFQW	1420
CHCT	840	WBT	1080	WLAC	1370	KFRC	610
CHGS	1120	WBTM	1370	WGN	720	KFRU	630
CHLS	730	WBZ	990	WLIB	720	KFBU	1100
CHMA	580	WBZA	990	WGR	550	KFDS	600
CHML	880	WCAC	600	WGST	890	KFSG	1120
CHNS	930	WCAD	1220	WGY	790	KFEC	600
CHRC	880	WCAC	1220	WHA	940	KFED	1220
CHWC	960	WCAH	1430	WHAD	1120	KFEM	1220
CHWK	1210	WC AJ	590	WHAM	1150	KFEN	1220
CHYC	730	WCAL	1250	WHAP	1300	KFEP	1220
CJBC	580	WCAM	1280	WHAS	820	KFEP	1220
CJBC	840	WCAO	600	WHAT	1310	KFEP	1220
CJBC	960	*WCAT	1280	WHAZ	1300	KFEP	1220
CJBR	960	WCAU	1200	WHA	860	KFEP	1220
CJCA	580	WCAX	1200	WHBC	1200	KFEP	1220
CJCB	880	WCAZ	1070	WHBD	1370	KFEP	1220
CJCI	690	WCBA	1440	WHBF	1210	KFEP	1220
CJGC	910	WCBD	1080	WHBL	1410	KFEP	1220
CJGX	630	WCBM	1370	WHBU	1370	KFEP	1220
CJHS	910	WCBS	1210	WHBY	1210	KFEP	1220
CJOC	1120	WCCO	810	WHDF	1200	KFEP	1220
CJOR	1030	WCDA	1350	WHDH	830	KFEP	1220
CJRM	600	WCFL	970	WHDI	1180	KFEP	1220
CJRW	600	WCGU	1400	WHDI	1180	KFEP	1220
CJRX	1120	WCHI	1490	WHEC	1440	KFEP	1220
CISC	580	WCKY	1490	WABO	1440	KFEP	1220
CKAC	730	WCLB	1500	WHFC	1420	KFEP	1220
CKCD	730	WCLO	1200	WHIS	1420	KFEP	1220
CKCI	830	WC TS	1310	WHK	1390	KFEP	1220
CKCK	960	WCMA	1400	WHN	1010	KFEP	1220
CKCL	580	WCOA	1340	WHO	1000	KFEP	1220
CKCO	890	*WCOC	883	WHOM	1450	KFEP	1220
CKCR	1010	WCOD	1200	WHP	1430	KFEP	1220
CKCV	880	WCOH	1210	WIAS	1420	KFEP	1220
CKCF	730	WCRW	1210	WIBA	1210	KFEP	1220
CKGW	690	WCSC	1310	WIBG	930	KFEP	1220
CKIC	930	WCSH	940	WIBM	1370	KFEP	1220
CKLC	840	WCSO	1450	WIBO	560	KFEP	1220
CKMC	1210	WDAA	1220	WIBR	1420	KFEP	1220
CKMO	730	WDAF	610	WIBU	1310	KFEP	1220
CKNC	580	WDAG	1410	WIBU	1310	KFEP	1220
CKOC	880	WDAH	1310	WIBW	580	KFEP	1220
CKOW	840	WDAY	940	WIBX	1200	KFEP	1220
CKPC	1210	WDBJ	930	WICC	1190	KFEP	1220
CKPR	930	WDBO	1120	WIL	1200	KFEP	1220
CKSH	1010	WDEL	1120	WILL	890	KFEP	1220
CKUA	580	WDGY	1180	WILM	1420	KFEP	1220
CKWX	730	WDOD	1280	WIOD	1300	KFEP	1220
CKX	540	WDRC	1330	WMBF	1300	KFEP	1220
CKY	720	WDSU	1250	WIP	610	KFEP	1220
CNRA	630	WDWF	1210	WIS	1010	KFEP	1220
CNRD	690	WLSI	1210	WISN	1120	KFEP	1220
CNRE	840	WDZ	1070	WIAC	1310	KFEP	1220
CNRL	580	WEAF	660	WJAG	1060	KFEP	1220
CNRM	910	WEAI	1270	WJAK	1310	KFEP	1220
CNRM	730	WEAN	780	WJAR	890	KFEP	1220
CNRO	600	WEAO	570	WIAS	1290	KFEP	1220
CNRQ	880	WEB	1290	WJAX	900	KFEP	1220
CNRR	960	WEBE	1210	WJAY	610	KFEP	1220
CNRS	910	WEBQ	1210	WJAZ	1490	KFEP	1220
CNRT	840	WEBR	1310	WJBC	1200	KFEP	1220
CNRV	1030	WEBW	560	WJBI	1210	KFEP	1220
CNRW	780	WEDC	1210	WJBK	1370	KFEP	1220
CNRX	690	WEDH	1420	WJBL	1200	KFEP	1220
UNITED STATES		WEEI	590	WJBO	1420	KFEP	1220
WEHS		WEHC	1490	WJBU	1210	KFEP	1220
WEI		WEI	1420	WOMT	1210	KFEP	1220
WEKA		WEWA	1420	WOOD	1270	KFEP	1220
WEKA		WEWA	1130	WOP	1500	KFEP	1220
WEKA		WEWA	1360	WOQ	1300	KFEP	1220
WEKA		WEWA	710	WOR	710	KFEP	1220
WEWA		WEWA	1460	WOT	1200	KFEP	1220
WEWA		WEWA	1490	WOK	1000	KFEP	1220
WEWA		WEWA	1210	WORD	1490	KFEP	1220
WEWA		WEWA	630	WOS	630	KFEP	1220
WEWA		WEWA	1130	WOF	1130	KFEP	1220
WEWA		WEWA	1300	KFH	1300	KFEP	1220
WEWA		WEWA	590	KFHA	1200	KFEP	1220
WEWA		WEWA	640	KFI	1210	KFEP	1220
WEWA		WEWA	1210	KFIO	1230	KFEP	1220
WEWA		WEWA	1500	KFJ	1200	KFEP	1220
WEWA		WEWA	1480	KFJF	1480	KFEP	1220
WEWA		WEWA	1370	KFJI	1370	KFEP	1220
WEWA		WEWA	570	WPOE	1370	KFEP	1220

Seek to Improve Music on Short Waves

The past success of transoceanic short-wave broadcasting has encouraged further research, with the result that the engineers that represent the big broadcasting systems are studying the signal variations of overseas transmitters by day and night.

transmission of music, which, unlike the voice, requires a much wider range of modulation frequency, and hence this requires methods of controlling the channel frequency.

located at Bound Brook, N. J., transmitting on a daily three-hour continuous schedule, is picked up regularly in South Africa, India, Australia, as well as most of central and mid-southern Europe, by American engineering representatives, and technicians of foreign broadcasting enterprises.

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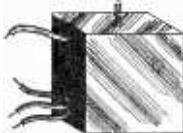
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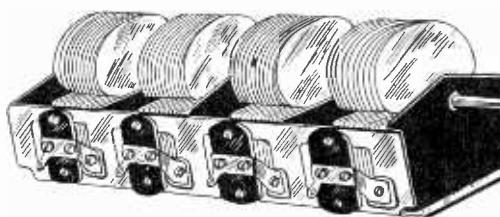
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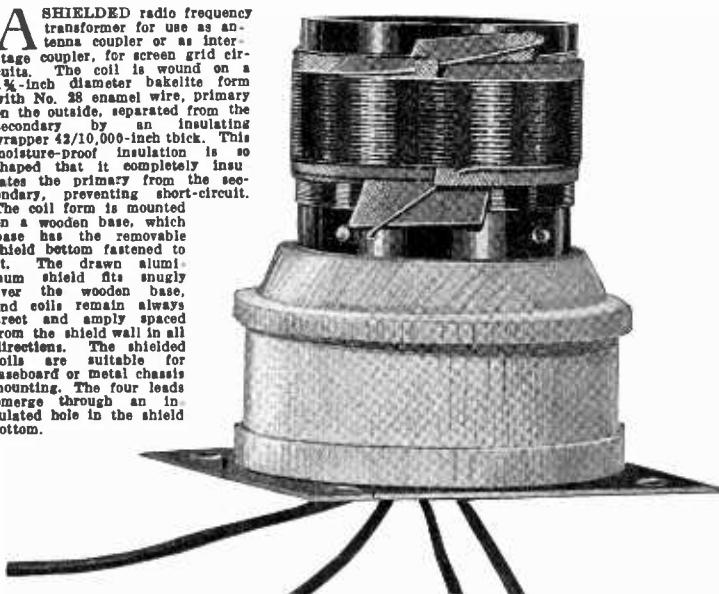
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High-Gain Shielded Coils

A SHIELDED radio frequency transformer for use as an antenna coupler or as interstage coupler, for screen grid circuit. The coil is wound on a 1½-inch diameter bakelite form with No. 28 enamel wire, primary on the outside, separated from the secondary by an insulating wrapper .42/10,000-inch thick. This moisture-proof insulation is so shaped that it completely insulates the primary from the secondary, preventing short-circuit. The coil form is mounted on a wooden base, which base has the removable shield bottom fastened to it. The drawn aluminum shield fits snugly over the wooden base, and coils remain always erect and amply spaced from the shield wall in all directions. The shielded coils are suitable for baseboard or metal chassis mounting. The four leads emerge through an insulated hole in the shield bottom.



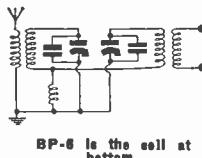
The coil comes already mounted on a shellacked wooden base, which is fastened at the factory to the shield bottom. Series A coil is illustrated.



The external appearance of the shield, with four 6/32 machine screws and nuts, which are supplied with each coil assembly.

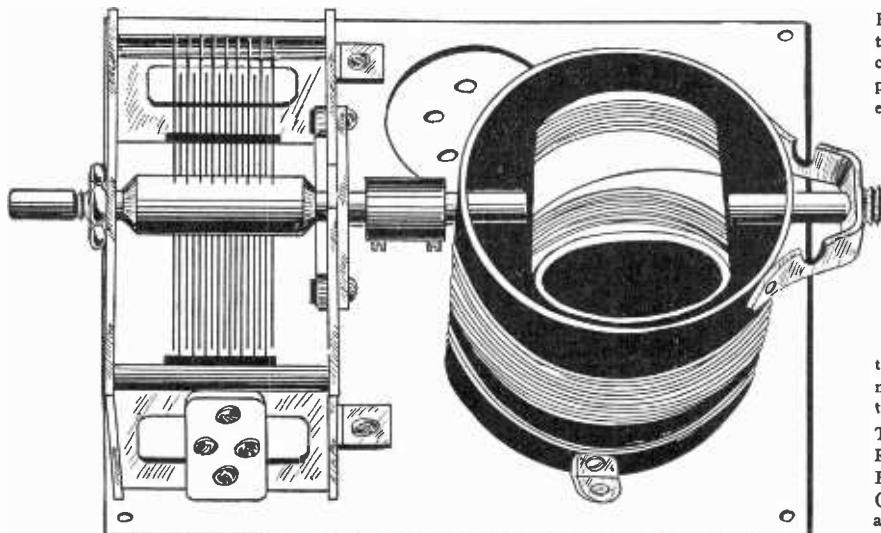
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ONE primary lead-out wire from the coil, for antenna or plate connection, has a braided tinned alloy covering over the insulation. This alloy braid shields the lead against stray pick-up when the braid alone is soldered to a ground connection. The outleads are 6 inches long and are color identified. The wire terminals of the windings themselves, and the outleads, are soldered to copper rivets. Each coil comes completely assembled inside the shield, which is 2½ inches square at bottom (size of shield bottom) and 3¾ inches high. High impedance primaries of 40 turns are used. Secondaries have 80 turns for .00035 mfd. and 70 turns for .0005 mfd.



Junior Model Inductances

The Series B coils have the same inductance and the same shields as the series A coils, but the primary, instead of being wound over the secondary, with special insulation between, is wound adjoining the secondary, on the form, with ½-inch separation, resulting in looser coupling. No wooden base is provided, as the bakelite coil form is longer, and is fastened to the shield bottom piece by means of two brackets. No outleads. Wire terminals are not soldered. Order Cat. B-SH-3 for .00035 mfd. and Cat. B-SH-5 for .0005 mfd.



Screen Grid Coil Co., 143 West 45th Street, New York (Just East of Broadway):

Enclosed please find \$..... (Canadian must be express or P. O. Money Order), for which send me prepaid the following:	
<input type="checkbox"/> A-40-80-S, each	\$2.25
<input type="checkbox"/> Matched set, A-40-80-S, \$1 matching 10.00	
<input type="checkbox"/> A-40-70-S, each	2.25
<input type="checkbox"/> Matched set of four A-40-70-S, 10.00	
<input type="checkbox"/> BT-L-AC and BT-R-DC, assembled, with condenser, link, socket and base, per pair	6.00
<input type="checkbox"/> C-6-CT-5, .0005 mfd. shielded coil for six-circuit tuner	each \$2.25
<input type="checkbox"/> C-6-CT-8, .00035 mfd. shielded coil for six-circuit tuner	each \$2.25
<input type="checkbox"/> BP-6	.25
<input type="checkbox"/> EQ-100, equalizer of 20-100 mfd. capacity, made by Hammerlund	.85

(Note: All coils come with shields, except BP-6 and BT-L.)

NAME..... ADDRESS.....

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If ordering C.O.D. put cross here. Post office fee will be added to prices quoted.

EXTREME accuracy in winding and spacing is essential for coils used in gang tuning. These coils are specially suited for gang condensers, because the inductances of all are identical for the stated size condenser. The coils are matched by a radio frequency oscillator. The color scheme is as follows: shielded wire outlead is for antenna or plate; red is for ground or B plus. (These options are due to use of the same coil for antenna coupling or interstage coupling.) Blue is for grid and yellow is for grid return. For .00035 mfd. the Cat. No. is A-40-80-S. For .0005 mfd. the Cat. No. is A-40-70-S. Where a band pass filter circuit is used the small coupling coil to unite circuits is Cat. BP-6. The connection is illustrated herewith.

Coils for Six-Circuit Tuner

Series C coils for use with six tuned circuits, as in Herman Bernard's six-circuit tuner, are wound the same as type A shielded coils, but the shields are a little larger (8 1/16-inch diameter, 3 1/8 inches high), and there are no shield bottoms, as a metal chassis must be used with such highly sensitive circuits. Fasten the brackets to the shield and then, from underneath the chassis, fasten the other arm of the two brackets to the chassis. Order Cat. C-6-CT-5 for .0005 mfd. and Cat. C-6-CT-8 for .00035 mfd. Five need for Bernard's circuit. If band pass filter coupling coil is desired order Cat. BP-6 extra.

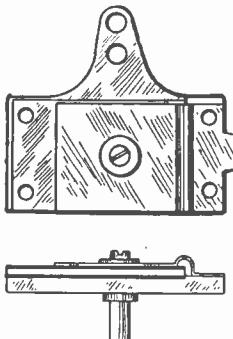
For a stage of screen grid RF, either for battery type tube, 222, or AC, 224, followed by a grid-leak-condenser detector, no shielding is needed, and higher per-stage amplification is attainable and useful. This extra-high per-stage gain, not practical where more than one RF stage is used, is easily obtained by using dynamic tuners. Two assemblies are needed. These are furnished with condensers erected on a socketed aluminum base. Each coil has its tuned winding divided into a fixed and a moving segment. The moving coil, actuated by the condenser shaft itself, acts as a varometer, which bucks the fixed winding at the low wavelengths and aids it at the high wavelengths, thus being self-neutralizing and maintaining an even degree of extra-high amplification throughout the broadcast scale.

Two assemblies are needed. For AC operation (224 RF and 224 or 227 detector), use Cat. BT-L-AC and BT-R-AC. For battery or A eliminator operation (222 RF and any tube as detector), use Cat. BT-L-DC and BT-R-DC.

BT-L for the antenna stage and BT-R for the detector input. BT-L consists of a small primary, with suitable secondary for the .00035 mfd. condenser supplied. BT-R has two effective coils, the tuned combination winding in the RF plate circuit, the inside fixed winding in the detector grid circuit.

The moving coils must be "matched." This is done as follows: Turn the condensers until plates are fully enmeshed, and have the moving coils parallel with the fixed winding. Tune in the highest wavelength station receiving above 450 meters surely. Now turn the moving coils half way round and retune to bring in the station. The setting that represents the use of lesser capacity of the condenser to obtain in that station is the correct one. If gang tuning is used, put a 20-100 mmfd. equalizing condenser across the secondary in the antenna circuit and adjust the equalizer for a low wavelength (300 meters or less).

HAMMARLUND 100 MMFD. EQUALIZER



The most precise and rugged equalizing condenser made, with 20 mmfd. minimum and 100 mmfd. maximum, for equalizing the capacity where gang condensers are used that are not provided with built-in trimmers. Turning the screw alters the position of the moving plate, hence the capacity. Cross-section reveals special threaded brass bushing into which screw turns, hence you can not strip the thread. If you turn the screwdriver down with accidental excess of force, the screw simply stops, no injury results, as this special equalizer does not rely on the delicate threads.

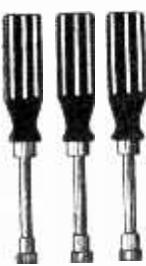
in bakelite. The screw receptacle is strong brass. Useful in all circuits where trimming capacity of 100 mmfd. or less is specified. Maximum capacity stamped on the condenser.

Order Cat. EQ-100, List Price 60c, Net Price 35c

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AMER-TRAN'S NEW POWER AMPLIFIERS



The American Transformer Company, makers of superb power amplifiers and components, has a new and marvelous line of push-pull power amplifiers, known as the "Series 80."

The six-tube power amplifier illustrated above is a three-stage system, with 227 first and second audio, and 250 push-pull output. Two 281 rectifiers are used, full wave. The first stage is transformer coupled, the second impedance coupled and the third transformer coupled. It is not intended this, or any other "Series 80" power amplifier, supply any voltage to any other device, e.g., a tuner. The five binding posts are two each for input and output and one for ground. The other posts are test jacks. The input or primary of the first transformer has an impedance of 500 ohms, for general use, including microphone input. Input impedance of 2,000 or 4,000 ohms can be furnished instead, on request. The final output has an impedance of 15 ohms, for dynamic speaker voice coils, but 500-ohm impedance for line transformers and 4,000-ohm impedance for magnetic speakers can be furnished instead, on request.

The three-stage 250 push-pull power amplifier is Cat. PA-86 and lists for \$195, wired, less tubes. Net price, \$144.66.

The three-stage product, with 245 push-pull output, has the same general appearance, audio circuit and impedance factors at input and output, but five tubes instead of six, due to the use of a 280 rectifier. This is Cat. PA-84, list price, \$160, wired, less tubes; net price, \$94.08.

The five-tube two-stage amplifier with 250 push-pull output, is Cat. PA-85, list price, \$180, wired, less tubes; net price, \$105.84.

The four-tube two-stage 245 PP output is Cat. PA-83, list price, \$145, wired, less tubes; net price, \$85.26.

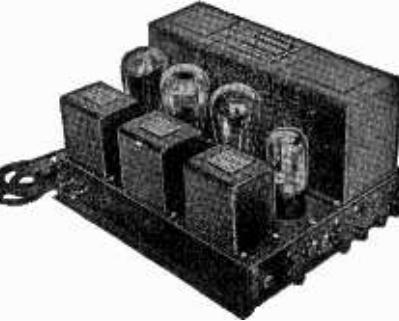
These power amplifiers are highly suitable for theatres, auditoriums, clubs, public address and home use. They are licensed by RCA and associates.

Two types of power transformers by Amer-Trans for those who want to build their own power amplifiers are Cat. PB-250 for 250 output, single or push-pull; and Cat. PB-245 for 245 output, single or push-pull. Cat. PB-250 furnishes power for two 281s and for two 250s. Two B supply chokes are built in. No filament voltage for tuner is supplied. Cat. PB-250 lists @ \$35; net, \$20.58. Cat. PB-245 furnishes power for a 280 and two 215s, besides 2½ volts AC for heaters of five tubes. Two B chokes are built in. List price, \$32.50; net, \$19.11.

Amer-Tran AF Transformers

First stage, de luxe, primary, in detector circuit, has 200 henrys inductance at 1 ma; turns ratio, 1-to-3. Cat. DL-1, list price, \$8.00; net, \$4.70. Push-pull input transformer; turns ratio, 1-to-2½; single primary; two separate windings for secondary; Cat. 151, list price \$12; net, \$7.05.

National Company's Power Amplifier



A 245 push-pull power amplifier especially suitable for powering AC tuners is the new model Velvotone. Uses one 280, one 227 and two 245. Furnishes 2½ volts AC for up to five other tubes, also plate voltages for tuner. Two stages of transformer coupling with output transformer. Cat. PPPA, list price, wired, \$97.50, less tubes; net, \$57.33. [Velvotone is licensed by RCA and associates.]

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<input type="checkbox"/> Cat. PA-85 @ 105.84	<input type="checkbox"/> Cat. DL-2 @ 4.70
<input type="checkbox"/> Cat. PA-83 @ 85.26	<input type="checkbox"/> Cat. 151 @ 7.05
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