HUGO GERNSBACK, Editor

RADIO CRAFT

IMPROVING SOUND EQUIPMENT

SEE PAGE 20

In this issue—

Servicing Theater Sound

Audio B-F Oscillator

Intercom for the Home

NOV 1946

25¢

CANADA 30¢

RADIO-ELECTRONICS IN ALL ITS PHASES

Teleran pictures—air traffic control by radar plus television.

Teleran—"radio eyes" for blind flying!

It's a television "information please" between airplane and airport—with the pilot's questions given split-second answers on a television screen mounted in the cockpit.

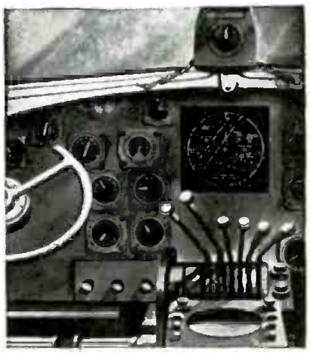
Teleran (a contraction of *TELE*vision—Radar Air Navigation) collects all of the necessary information on the ground by radar, and then instantly transmits a television picture of the assembled data to the pilot aloft in the airplane.

On his receiver the pilot sees a picture showing the position of his airplane and the position of all other aircraft near his altitude, superimposed upon a terrain map complete with route markings, weather conditions and unmistakable visual instructions. The complex problem of air traffic control is well handled by Teleran.

Teleran—another achievement of RCA—is being developed with Army Air Forces co-operation by RCA Laboratories and RCA Victor, endless sources of history-making developments in radio and electronics. They are also your assurance that *any* product bearing the RCA or RCA Victor monogram, is one of the finest instruments of its kind science has yet achieved.

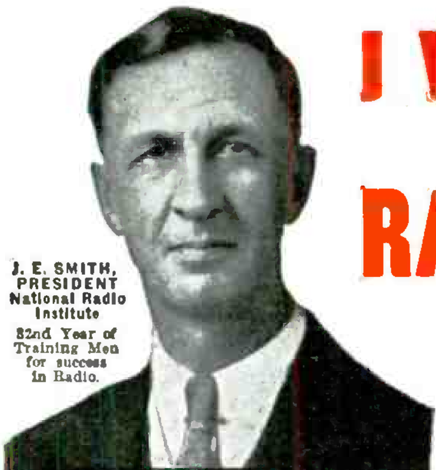
• • •

Radio Corporation of America, RCA Building, Radio City, New York 20 . . . Listen to The RCA Victor Show, Sundays, 2:00 P. M., Eastern Standard Time, over the NBC Network.



Instrument Panel of the Future. The Teleran indicator, mounted in a cockpit, simplifies the pilot's job by showing his position relative to the airport and to other planes in the vicinity. It promises to become one of the most useful developments in the history of aviation.

RADIO CORPORATION of AMERICA

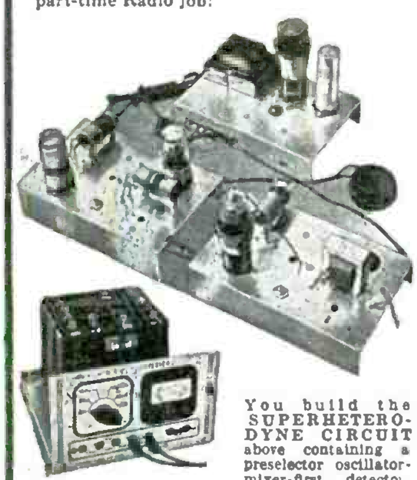


J. E. SMITH, PRESIDENT National Radio Institute
32nd Year of Training Men for success in Radio.

I WILL TRAIN YOU TO START
A SPARE TIME OR FULL TIME
RADIO SERVICE BUSINESS WITHOUT CAPITAL

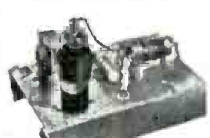
You Build These and Many Other Radio Circuits with 6 Kits of Parts I Supply

By the time you've conducted 60 sets of Experiments with Radio Parts I supply, made hundreds of measurements and adjustments, you'll have valuable PRACTICAL Radio experience for a good full or part-time Radio job!



You build MEASURING INSTRUMENT above early in Course, useful for Radio work to pick up EXTRA spare time money. It is a vacuum tube multimeter, measures A.C., D.C., R.F. volts, D.C. currents, resistance, receiver output.

You build the SUPERHETERODYNE CIRCUIT above containing a preselector oscillator-mixer-first detector, i.f. stage, diode-detector-a.v.c. stage and audio stage. It will bring in local and distant stations. Get the thrill of learning at home evenings in spare time while you put the set through fascinating tests!



Building the A. M. SIGNAL GENERATOR at right will give you valuable experience. Provides amplitude-modulated signals for test and experimental purposes.

The men at the right are just a few of many I have trained, at home in their spare time, to be Radio Technicians. They are now operating their own successful spare time or full time Radio businesses. Hundreds of other men I trained hold good jobs in practically every branch of Radio. Doesn't this PROVE my "50-50 method" of home training can give you BOTH a thorough knowledge of Radio principles and the PRACTICAL experience you need to help you make more money in the fast-growing Radio industry?

Let me send you facts about opportunities in the busy Radio field. See how knowing Radio can give you security, a prosperous future . . . lead to jobs coming in Television, Electronics. Send coupon NOW for FREE Sample Lesson and 64-page, illustrated book. Read how NRI trains you at home in spare time. Read how you practice building, testing, repairing Radios with SIX BIG KITS of Radio parts I send you.

Many Beginners Soon Make Extra Money In Spare Time While Learning

The day you enroll I start sending EXTRA MONEY JOB SHEETS. You LEARN Radio principles from my easy-to-understand, illustrated lessons—PRACTICE what you learn by building, testing and experimenting with parts I send—USE your knowledge to make EXTRA money fixing neighbors' Radios in spare time while still learning! From here it's a short step to your own full-time Radio Shop or a good Radio job!

Future for Trained Men Is Bright In Radio, Television, Electronics

It's probably easier to get started in Radio now than ever before, because the Radio Repair Business is booming. Trained Radio Technicians also find profitable opportunities in Police, Aviation, Marine Radio, Broadcasting, Radio Manufacturing, Public Address work. Think of even greater opportunities as Television, FM, and many new, war-developed Electronic devices become available to the public! Soon, there will be more Radio equipment to install, operate, maintain and repair than ever before in all history! Get the facts on all these opportunities. Send for FREE books now!

Find Out What NRI Can Do For You

Mail Coupon for Sample Lesson, "Getting Acquainted with Receiver Servicing," and my FREE 64-page book. It's packed with facts about Radio's opportunities for you. Read the details about my Course. Read letters from men I trained, telling what they are doing, earning. See how quickly, easily you can get started. No obligation! Just MAIL COUPON NOW in an envelope or paste it on a penny postal. J. E. SMITH, President, Dept. 6MX, National Radio Institute, *Pioneer Home Study Radio School*, Washington 9, D. C.

I Trained These Men — SPARE TIME RADIO BUSINESS

"I have a spare time Radio and Electrical business of my own which has been very profitable, due to the efficient training I received from your Course. Last year I averaged over $50 a month."—FRED H. GRIFFIE, Route 3, Newville, Pa.

"I am doing radio work in my spare time, and find it a profitable hobby. My extra earnings run about $10 a week. I certainly am glad I took your N.R.I. Course."—FERDINAND ZIRBEL, Chaseley, North Dakota.

"About six months after I enrolled I started making extra money in radio. I am a farmer and just work on radios evenings and stormy days. That brought me a profit of $600 in the last year."—BENNIE L. ARENDS, RFD 2, Alexander, Iowa.

I Trained These Men — FULL TIME RADIO BUSINESS

"Not long ago I was working 16 hours a day in a filling station at $10 a week. Now I have my own radio business and average over $60 a week. The N.R.I. course is fine."—ALBERT C. CHRISTENSEN, 116—10th Avenue, Sidney, Neb.

"Previous to enrolling for your radio training I made $12 per week in a hardware store. Now I operate my own repair shop, and often clear $35 to $45 a week."—FREDERICK BELL, 76 Golf Ave., St. Johns, Newfoundland.

"Am making over $50 a week profit from my own shop. Have another N.R.I. graduate working for me. I like to hire N.R.I. men because they know radio."—NORMAN MILLER, Hebron, Neb.

SAMPLE LESSON FREE

I will send you a FREE Lesson, "Getting Acquainted With Receiver Servicing," to show you how practical it is to train for Radio at home in spare time. It's a valuable lesson. Study it—keep it—use it—without obligation! Tells how Superheterodyne Circuits work, gives hints on Receiver Servicing, Locating Defects, Repair of Loudspeaker, I.F. Transformer, Gang Tuning, Condenser, etc. 31 Illustrations.

My Radio Course Includes
TELEVISION • ELECTRONICS
FREQUENCY MODULATION

GOOD FOR BOTH 64 PAGE BOOK SAMPLE LESSON **FREE**

J. E. SMITH, President, Dept. 6MX
National Radio Institute, Washington 9, D. C.
Without obligating me, mail your Sample Lesson and 64-page book. FREE. I am particularly interested in the branch of Radio checked below. (No salesman will call. Please write plainly.)

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( ) Industrial Electronics
( ) Public Address Systems
( ) Ship, Harbor, Gov't., Military Radio

(If you have not decided which branch you prefer—mail coupon for facts to help you decide.)

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Address ....

City .... Zone .... State ....

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National Union Announces an

EXCLUSIVE RADIO MERCHANDISING PLAN for Service Engineers

PRESENTATION MODEL No. G619. *6 Tubes. AC-DC. Tuned R.F. Stage. Superheterodyne Circuit. Loop Aerial. Automatic Volume Control. Illuminated Slide-Rule Dial. Standard American Broadcasts. Mahogany Veneer All-Wood Table Cabinet, 13" x 8¾" x 6½".*

COMPANION MODEL No. 571. *5 Tubes. AC-DC. Superheterodyne Circuit. Built-in Antenna. Automatic Volume Control. 2-Gang Air Condenser Tuning. Illuminated Slide-Rule Dial. Standard American Broadcasts. Walnut Veneer All-Wood Table Cabinet, 13⁵⁄₁₆" x 7⅞" x 8⅛".*

HERE IT IS AT LAST! The radio line thousands of service engineers have been waiting for—yes, the radio that has *everything* the service trade needs to cash-in on today's big pent-up new set demand.

And who else but National Union could provide a merchandising plan for radio sets—so perfectly fitted to the service engineer's special needs?

For over 15 years National Union products, plans and policies have been shaped for the exclusive benefit of service dealers.

And now N.U. RADIO SETS are here—for the same service men who have so long known and used other N.U. products—and have found the N.U. way of doing business a better, more profitable one for their special type of operations.

THE LINE—5 models, of which one 5-tube and one 6-tube model are now ready; three others available in 90 days.
THE PRODUCT—Top quality throughout; precision-built chassis; beautiful cabinets in modern designs.
PERFORMANCE—Thoroughly up-to-the-minute; N.U. sets compare with the best in their class.
PRICES—Competitive with established brands.
VOLUME REQUIREMENTS—None! N.U. sets are not sold on a franchise basis. Order whatever quantity you need.
DISTRIBUTION—Sold only through N.U. Distributors and Service Dealers.

OTHER MODELS NOW BEING PLANNED

- A 3-Way (AC-DC-Battery) Portable Model.
- A Combination Table Model Radio-Phonograph with Automatic Record Changer.
- A 6-Tube Battery-Powered Farm Radio Table Model.

Here, for the first time, is a practical post-war radio line for the service engineer to handle—a group of fine modern radio sets—but *above all* a proven merchandising plan which *fits*. Ask your N.U. Distributor for the complete facts today!

NATIONAL UNION RADIO CORPORATION, NEWARK 2, N. J.

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Transmitting, Cathode Ray, Receiving, Special Purpose Tubes • Condensers • Volume Controls • Phototubes Panel Lamps • Flashlight Bulbs • Radio Sets • Auto Vibrators • Ballasts • Batteries

MID-AMERICA HAS EVERYTHING FROM "A" TO "Z"

ANTENNAS

32½" Collapsbl Vertical........49c
10 Mtr Collapsbl Vertical..........$1.49
12½ Foot Telescopic..........$1.95
Phantom A-27, 2-4.5 mc..........$1.49

CABLE

Co-Axial RG8U Standard
Amphenol 52 ohm.
Per 100 ft..........Per ft. 8c
Per 1000 ft..........Per ft. 6c
Co-Axial RG54-A/u, 58 ohm
Per 100 ft..........Per ft. 7c
Per 1000 ft..........Per ft. 5c
Eight cond. shielded, colored rubber ins. six of #20, two of #16. Heavy rubber jacket, external tinned woven shielding. O.D. 9/16".
Per 100 ft..........Per ft. 10c
Per 1000 ft..........Per ft. 7½c

COIL FORMS

Kit of 10 Ceramic transmitting coil forms..........$1.49

CONDENSERS

Kit of 10 Bathtub condensers $1.49

AIR PADDER CONDENSERS—
Ceramic Insulation, Screwdriver Adjmt.
100 mmf..........29c
140 mmf..........49c
Following sizes available—5, 15, 25, 35 and 50 mmf, each..........19c
KIT of 10 Asstd. Air Padder Condensers..........$1.49

G.E. PYRNAOL CONDENSERS

MFD	VDC	PRICE	MFD	VDC	PRICE
.25	1000	39c	.1	7600	$1.95
1	500	39c	4	1500	$2.95
1	600	49c	10	1000	$2.95
2	600	89c	12	660	$3.50
1	1000	98c	15	1500	$3.95
6	600	98c	1.5	6000	$4.95

HEAVY DUTY OIL FILLED CNDNSRS

MFD	VDC	PRICE	MFD	VDC	PRICE
.075	16000	$4.95	3	4000	$ 4.50
1.5	6000	8.95	10	6000	24.95

Dual 1 mfd 3000 VDC....$3.95
Dual 1 mfd 7500 VDC....$9.95

TUBULAR PAPER CONDENSERS

MFD	VDC	PRICE	MFD	VDC	PRICE
.01	600	9c	.3	200	10c
.006	1000	10c	.1	1000	15c
.05	600	10c	.004	1600	19c

VARIABLE CONDENSERS

GANG	MMF	PRICE	GANG	MMF	PRICE
2	10	49c	1	500	$1.29
1	50	49c	2	370	$1.49
1	13	69c	3	75	$1.49
2	35	98c	4	140	$1.95

MISCELLANEOUS CONDENSERS
Hi-voltage Mica. Kit of 10 pieces, from 600-2500 volts..........$2.95
Hi-voltage Mica. Kit of 10 pieces, from 3000-5000 volts..........$5.95
Mica. Kit of 25 pieces. Asstd sizes from .00005 to .001, 300-600 v., per kit....$1.98

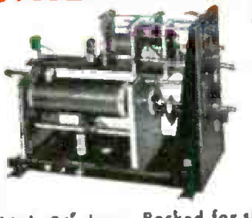
DYNAMOTORS

Kit of 3 listed below..........$4.95
SIZE: 3⅞" x 6" long, excluding shaft. R.P.M. 4000.

INPUT VDC	INPUT AMPS.	OUTPUT VDC	OUTPUT AMPS.
6-9	6.4	450	60
12	3.5	480	42
24	1.75	480	42

MID-AMERICA SPECIALS

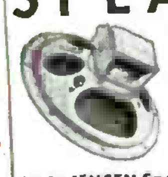
AT-3 Antenna Tuning Unit



An outstanding achievement in high frequency design! Covers all frequencies between 1.5 and 18 MC without use of plug-in inductance. Tunes any single wire antenna from 15 ft. whip to long wire. Ceramic insulation constructed to withstand high r. f. voltages. Simple to operate. Black wrinkle finish case measures 10¼" wide, 14½" high, 24" deep. Packed for shipment—wt. 56 lbs. Less 12 mmf and 50 mmf vacuum condensers..........

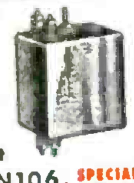
SPECIAL PRICE $26.95

SPEAKERS



5" Alnico Speaker, 4 Ohm VC, Limited Quantity.......$1.70
6" PM 2.5 Alnico V . $2.95
10" PM, 18 oz. slug . $7.95
AP-10 JENSEN Speechmaster, 5 Watt PM in metal housing less base.... $6.95

HEAVY DUTY LINE FILTER



Solar Elim-O-Stat
Type EN106, CSL53199, 20 amps, 115 V.A.C., 600 V.D.C. SPECIAL $1.79

QUANTITY BUYERS

Dealers ... Jobbers ... Industrials ... Schools ... and other quantity buyers — write for special trade discounts on items listed as well as hundreds of others.

HAND SET

Type TS-13
Telephone type with 200 ohm carbon mike and 2000 ohm earphone plus talk switch and cords with plugs..........$2.95

HEAD SET

Type HS-23
8000 ohm impedance, with cushions, 12" cord and PL-54 plug..........$1.50

INVERTERS

Input 27 VDC 35 amps, output 115 VAC 4000 cps..........$4.95
Input 24 VDC 1 amp., output 26 VAC 400 cps 6 VA..........$1.95

KEYS

Transmitting J-38..........75c
Automatic Keyer TG-10-H with oscillator and 25 watt amplifier. 110 VAC, 60 cycle operation (less tubes)..........$39.95

MICROPHONES

Single button carbon hand mike, with press-to-talk switch, 5 ft. cord with PL-68 three circuit plug..........$1.75
Single button carbon lip mike. Fastens over upper lip, attaches to headset. With short cord and PL-291 plug..........89c
Single button carbon mike. Attaches to headset and held in front of mouth by bracket. Aviometer type 9042..........98c
KIT of 3 microphones, as listed above $2.95

IMPORTANT!

To assure fastest possible service and delivery, please send 25% deposit with your orders. Balance C.O.D. Send orders to store address. All prices shown are F.O.B. Chicago warehouse.

GUARANTEED

All items shown in this ad are guaranteed as rated by nationally-advertised manufacturers and are new, unused and in perfect condition.

Motor Speed Controls

10 ohm, 7.07 amp, 500 watt, flush mounting..........$3.95
12.5 ohm, 10 amp, 500 watt, bracket mounting..........$3.95
175 ohm, 3.7 amp, 800 watt, 125 volts, bracket mounting..........$4.95

POWER SUPPLIES

Portable vibrator type, input 6/12/24 VDC, output 200 VDC 120 ma..........$1.95
Mobile, dynamotor type, input 12 VDC 12 amps, output 275 VDC 110 ma, and 500 VDC 50 ma, complete with fuse and filters..........$9.95

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Long Wave Receiver RAK-7, 15 to 600 KC, 110 VAC operation, complete with power supply and tubes..........$64.50

RECTIFIER

Dry Disc
Full-wave, 64 VAC input, 30.2 to 33.5 VDC output at 5.2 amps..........$4.75

RESISTOR KITS

20 asstd—5, 10, 25 watt wire wound, popular sizes..........$1.79
10 Candohms 5 to 20 watts, IRC or equiv..........75c

RHEOSTATS

50 ohm, 25 watt..........59c
70 ohm, 25 watt..........59c
2500 ohm, 25 watt..........79c

SWITCHES

Antenna
DPDT Hi-voltage, knife..........39c

MICROSWITCHES
Type C, white top, SPST, normally closed, #WZ-7RSTC2..........39c
Type C, #BZ-RS, SPDT..........39c
Type C, #BZ-3RDTC, SPDT..........39c
GE #CR1070C103-A3 momentary SPST normally closed..........39c

PRESS-TO-TALK
DPST, NO, with 5 ft cord, UL-68 and JK-48..........24c

PUSH BUTTON
10 Button, momentary contact, non-locking, right hand..........49c
10 button, momentary contact, non-locking, left hand..........49c
5 Button, pos. action, locking..........49c
4 Button, pos. action, locking..........49c

TOGGLE
Lever type, 3PDT 10 amp 250 VAC 59c
Push type SPST NO, 3 amp 250 VAC..29c
KIT OF 10 SELECTOR SWITCHES..$1.49

TUBES

Immediate Delivery
6AC7..........97c
6AG5..........$1.19
6J6..........97c
6SL7GT..........79c

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Universale output transformer, single or push-pull tubes to any voice coil. Rate at 10 watts..........$1.20
Power transformer, primary 105-125 VAC 60 cps, Secondary 5 volts 190 amps..$14.95

TRANSMITTER

BC-223-A, 80 meter band; phone, CW, ICW; VFO or crystal controlled; 25 watt output..........$22.50

Transmitter-Receiver

Portable FM Transceiver SCR-510, range 5 miles, 20 to 27.9 MC, crystal controlled with 80 crystals, complete..$79.50

VOLUME Control

Kit, 10 volume and tone controls, no switches, long shafts..........$1.79

WIRE

Single conductor #18 solid, rubber ins. OD ⅛" black, green only
Per 100 ft..........69c
Per 1000 ft..........$5.45
Two conductor, #14 stranded with external tinned woven braid, O.D. ⅜"
Per 100 ft..........Per ft. 8c/ft.
Per 1000 ft..........Per ft. 6c/ft.

ZILLIONS

of other big-value parts, transmitters, tubes, and electronic equipment listed in MID-AMERICA'S Catalog. It's free for the asking. Just send coupon below and your FREE copy will be mailed at once.

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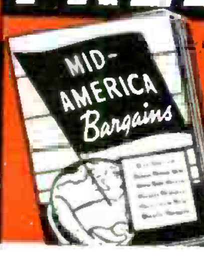

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Send me at once—ABSOLUTELY FREE—your brand new catalog listing hundreds of "hard-to-get" radio parts, transmitters, and electronic equipment ... ALL AT MONEY-SAVING PRICES.

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AND POPULAR ELECTRONICS

Incorporating

SHORT WAVE CRAFT TELEVISION NEWS

RADIO & TELEVISION

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IN AN EARLY ISSUE

Instability in Apparatus
Complete Tracer in Probe
The Cinematic Analyzer
Antenna Fundamentals

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Contents November, 1946 Volume XVIII No. 2

ON THE COVER

The experimental home sound-recording laboratory of Mr. J. C. Hoadley at West Newton, Mass., is shown on our cover this month. The two-unit speaker cabinet is described in the story on page 20. The recorder is at right, and with other features of the lab, will be described in future articles.

Chromatone by Alex Schomburg from photo by J. C. Hoadley

By HUGO GERNSBACK

THE TELE-THEATRE

The Tele-Chain-Theatre in Every U. S. Town Now Feasible

AS we have intimated many times before in these columns, television applications are far more complex than those of radio.

Thus radio, besides having penetrated the home, is also used to a considerable extent in automobiles, in schools, in factories, in rest rooms, and in many other locations. Television will not only duplicate this penetration, but will also go into many places where radio has never gone before.

To mention a few, retail and department stores are already beginning to display and sell merchandise via television. Thus a showing by a famed couturière or modiste can be done routinely from a central stage. Television outlets in various parts of the store, in lounges, etc., will faithfully reproduce in colors the actual event on the floor where the showing is held. Thus, instead of exhibiting the latest modes to a comparatively few women, thousands can now view.

The factory superintendent can supervise operations on his multi-screens from all over the shop and see what is going on in any part of the plant.

It will be simple for the head of a large organization to talk to all his executives so they can not only hear, but see him as well. This from a psychological viewpoint is a great improvement over the ordinary public address system now in vogue.

Merchandising in general will be tremendously stimulated by television. The store window now becomes a place to view not only a few items, scattered in the window, but the passerby will see displays from the entire store via the large television screen in the window.

Such novel expansions of television in the years just ahead will be far more complex than anything we have known in our past and present radio days.

Commercial television—an endeavor totally apart from television in the home—will soon be big business. The two branches should never be confused with each other because *they are distinct and separate*.

Naturally, commercial television sets are elaborate and expensive affairs; therefore, the price consideration is not of great importance if we compare it with the television receiver in the average home.

With the recent advances in business television, the television theatre envisaged for many years will soon be a reality. It is now much nearer in realization than it ever was, and it is certain that before many years have elapsed, the United States will have many such proposed theatres.

We reprint, here, an editorial from the January-February 1932 issue of the writer's former publication, TELEVISION NEWS. What was said 14 years ago holds good today, indeed, the television theatre is now a positive necessity.

In our smaller communities, particularly, the lack of the live theatre is felt acutely. The motion picture—canned entertainment—must always remain synthetic. It is never *real*, no matter how good or gripping the film play.

But a tele-theatre audience, viewing a television production, knows it faces live actors at the exact instant the action is unrolling—not months or years afterwards. There is a vast psychological difference between a motion picture play and a televised one. Television now has it in its power to bring a great cultural force to every stratum of the entire country. The 1932 article follows:

THE TELE-THEATRE

(An editorial from the Jan.-Feb. 1932 issue of TELEVISION NEWS.)

It is pretty well conceded, by most authorities on the subject, that the "legitimate" theatre is doomed to extinction in the not-too-distant future.

The great inroads which the motion picture has made on the legitimate stage, are becoming more serious right along and, if something is not done soon, we may have nothing but motion pictures left; because, from year to year, it becomes more unprofitable for producers to put on legitimate performances. The reason for this is, of course, that it is impossible to give a "legitimate" performance for 50c—which would then be competing with the motion-picture houses. The prices for the drama in New York, for a good orchestra seat, are from $3.50 up; and for musical comedy shows from $6.60 up. Plainly, these prices are too high. Hence, the decline of the legitimate theatre.

What, then, is the solution? I propose the following remedy, which I believe is sound; and I am certain that it will have to come to pass in the not too distant future. *Television is the key to the situation.*

Audience and Distant Stage Joined by Television

Recently, when the Sanabria Giant Television Screen was about to be exhibited at the *Broadway* Theater in New York City, I was asked by the management to supply some new ideas, to attract the public at large and secure favorable publicity for television.

I suggested, at the time, that an attempt be made to connect the stage of another theatre to the one at the *Broadway* Theater, and televise a distant performance on the *Broadway* screen. This suggestion was adopted, and the *Broadway* Theater, by means of a television transmitter, picked up the images *(Continued on page 54)*

RADIO-ELECTRONICS

Items Interesting

TELETYPERS which sent impulses shaping the actual letters being transmitted were used by the German forces, investigators of the Department of Commerce reported last month.

Standard American teleprinters send impulses that activate a separate printing key for each letter, while the Nazi instrument sent impulses that formed the vertical and horizontal lines of actual letters. One advantage of this system was that interference in the circuit distorted the shape of the letters in words instead of printing the wrong letters as with American teletypes.

Described as simple and rugged, the German machine weighed only 60 pounds. Chief disadvantage was reported to be the fact that it can only send 150 characters a minute.

A MASS SPECTROMETER recently devised to check leaks in vacuum apparatus or other air-tight equipment is sensitive enough to detect a leak so small that it would take more than a thousand years to deflate an ordinary auto tire.

The leak detector, scientists of the General Electric Co. stated last month, discovers helium gas in quantities as small as 1 in 400,000. The gas is sprayed over an area suspected to contain a leak, and as soon as an ultra-minute quantity has penetrated the vacuum space, its presence is indicated.

Immediate application of the detector is for tests of high-vacuum equipment, ranging from ordinary radio tubes to the gigantic vacuum chambers used in atom-smashing apparatus. It is expected to find employment also in the chemical industry and other fields where high-vacuum processes are important.

A leak which would deflate the balloon in 6000 years is detectable.

PRICE CUTS on "off-brand" radios were foreshadowed last month by two of New York City's largest radio-store chains. Sales were held by both chains, at which table models of other than nationally-known brands were sold at a reduction of as much as 20 percent.

Spokesmen for both concerns stated that the sales were for the purpose of "clearing stocks for standard brands." An increasing tendency on the part of the public to wait for nationally-known names and a distrust of some of the unknowns turned out in the early part of this year appears to be the main factor influencing the slow sale of "off-brand" radios. A second important factor is the increasing production of standard sets, which during the summer months outstripped the highest pre-war rate by almost 20 percent.

FLUORESCENT lighting interference with radio reception may be greatly reduced with a simple piece of screenwire, Dr. L. F. Shorey of the University of Vermont declared last month.

Speaking before the Illuminating Engineering Society in its convention at Quebec, Dr. Shorey, together with S. M. Gray of Sylvania Electric Products, Inc., presented a study of radio interference caused by fluorescent lamps in the home. Their report discusses how such interference is measured and reduced below a tolerable noise level.

Total interference, they said, results from three sources; feedback through the wires of the house circuit; radiation of the high-frequency current components from the wires; and radiation coming directly from the lamps.

Line feedback is reduced by the use of an electrical filter, while bulb radiation interference is reduced by the application of a wire-mesh screen *built into the lamp shade.*

"By a proper combination of these two schemes," they declared, "total interference is suppressed to a quite satisfactory level even with small distances separating the lamp and receiver antenna."

COST OF RADAR research and development was greater than that of the atomic bomb, states a booklet issued last month by Wesley W. Stout, former editor of *The Saturday Evening Post.*

According to Mr. Stout, $2,700,000,000 worth of radar equipment had been delivered to the services up to July, 1945, while the cost of the atomic bomb is given as around $2,000,000,000.

RADAR SETS will be used in studying the atom at the University of California, Professor Ernest O. Lawrence of cyclotron fame told physicists last month.

The radar equipment will be used to energize a *linear accelerator*, a device in which the particles to be speeded up are projected down a cylinder divided into sections. An electrical charge is applied to each of these sections at the correct instant to give the moving particle an accelerating impulse.

Fifteen radar sets, each connected to one section of the accelerating tube, will furnish the shocks which speed up the particles.

The linear accelerator is not a new device, but was abandoned in favor of the cyclotron because before the war no devices existed which could supply large amounts of power at high frequencies. Accelerations of two million volts were the utmost that could be obtained. With postwar apparatus, a billion volts is a theoretical possibility.

A RADIO "BINGO" GAME was raided by police last month, and summonses issued to the parties responsible for the game. The incident occurred at Radio CKAC, Montreal, and the persons called upon to justify their actions in court are Julien Riopel, organizer and producer of the game, and Conrad Giguere, representative of the sponsor.

The game, which is called "Zingo," was played with the aid of 45,000 cards distributed throughout the city, on which the players recorded their numbers in standard bingo fashion.

Unceremoniously halted by the Montreal morals squad on its third presentation, all equipment has been impounded to await court test of its legality.

TELEVISION RECEIVER shortage does not exist (if you want the right models) a prominent television manufacturing executive stated in New York last month. His company, he said, was ready to make immediate delivery on a de luxe projection model selling for approximately $2750. Other companies were advertising models priced from $2400 to as "low" as $600.

MONTHLY REVIEW

to the Technician

PARALLEL RADIO BEAMS determine the true speed of an airplane with an accuracy impossible in any earlier method of measurement, the Army Air Forces reported last month.

Three parallel beams at right angles to the course are used. The speeding planes cut these beams as they pass over the course, and as they cut each beam send a signal to the ground. The elapsed time between the signals is compared with the known distance between the beams, and the speed computed. The method may be used with either high- or low-flying planes.

Numerous other methods have been used to measure true air speed, but all had severe limitations. Various types of instruments installed in planes give approximate but not true speed. A radar system which followed the plane in flight was not sufficiently accurate, while a method of timing by use of vertical wires, cameras and a timing motor was effective only at low altitudes.

The radio beam method operates accurately in any weather and any altitude, and is the first system capable of measuring speed at or above the speed of sound. A similar installation at Muroc Army Air Base, Calif., will be used to check the speed of rockets and pilotless aircraft.

TELEVISION RECEIVER COSTS are likely to be considerably higher than previously estimated, the *New York Herald-Tribune* reported last month. Present indications, the paper stated, are that prices will be roughly one-third to one-quarter higher than originally expected. With installation and guaranty costs added, the advance becomes even more impressive.

This would place some of the lowest-price sets close to $300. Many of these, it was indicated, will include only television sight-and-sound, with standard frequency modulation broadcasting reserved for the higher-priced models.

Just what effect increased prices will have on the market is difficult to estimate, it was said. That the increases will come as a disappointment to many would-be purchasers of sets can be inferred from the recent survey released by Sylvania Electric Products, Inc. The survey showed that the average price quoted by families interested in buying a set is between $200 and $250. However, 43 percent thought they would pay between $150 and $250.

Meanwhile, New York newspapers were carrying advertisements of television-AM-FM-phonograph combinations in elaborate cabinets at $2400, with a cheaper model at $1500; "orders are being taken" for another set at $600.

LIGHT-WEIGHT RADAR newly designed for planes will increase flying safety, according to a last month's release by the Army Air Materiel Command. Only a little larger than a home radio, the new apparatus weighs 125 pounds, and can be used in any craft large enough to carry five passengers. The new radar, designed to remove the hazard of flying in darkness or fog, has a 360-degree microwave scan, and reflections from objects give accurate fluorescent pictures of cities, rivers and terrain.

By flipping a switch, the scope can be made to trace any one of five ranges. The large-scale details of the four-mile setting are best suited for close traffic flying, while the 90-mile range is most useful for cross-country navigation. The other ranges are intermediate.

The new device, known as the APS-10, is the first of a series of projected light-weight, easy-to-operate and maintain search radars. It was developed in conjunction with the government's Radiation Laboratory in Massachusetts, and with radar manufacturers. Future plans call for a 75-pound unit, which will provide even greater range at still lower cost.

COSMIC RAYS may cause a radio set to go "completely berserk" at high altitudes, an Army Air Force report stated last month. The report was based on experiments carried on by a B-29 which was converted into a flying laboratory to operate at 35,000-foot altitudes.

These rays and "other mysterious energy radiations" may make considerable modifications necessary in high-flying radio and radar apparatus for planes and rockets, according to the report.

(Yet radio waves themselves do not seem affected, otherwise the recent classic moon-radio experiment, where waves were reflected from the moon to the earth, could not have taken place.—*Editor)*

RADIO PRODUCTION will reach a peak late in 1947, R. C. Cosgrove, vice-president and general manager of the Crosley Corporation, told the appliance group of the Western Merchandise Mart.

The present capacity for manufacturing radios is roughly double that of the prewar period, he stated. Radio production for June, the last month for which figures were available, was 1,378,000 sets. This rate sets an all-time record, but is still lower than manufacturing capacity would permit.

SIR JAMES JEANS, possibly the most widely-read scientist of the present day, died on September 17 at his home in Surrey, England, after suffering some time from a heart condition. His age was 69.

Known best to the public for his interpretations of modern science in common language, he was known to his fellow scientists as a cosmogonist, and was prominent in the development of nebular theories.

Probably more important to the world were his many books for the layman, which made it possible for the common man to get an idea of what the "long-hairs" were talking about. Extending even to nucleonics and the Einstein theory, these books, with those of his colleague, Sir Arthur Eddington, and others, did much to dispel the suspicion of and enmity toward science so common among the public during the last generation.

Sir James spent part of his career in the United States, serving as Professor of Applied Mathematics at Princeton University for five years, during the period Woodrow Wilson was president of that institution.

ANTENNA INSTALLATION, considered a serious problem in marketing television receivers, has been solved by one manufacturer by setting up an independent installation company. According to a statement issued last month by Hamilton Hoge, president of U.S. Television, the new company, Television Installations, will personally supervise all consumer installations on UST television receivers.

These installation groups will consist of teams of two men—one to read the pattern at the receiver and the other to make necessary adjustments on the roof. The men will be equipped with a two-way telephone to work together closely.

By R. F. SCOTT

MAGNETOSTRICTION PICKUP

A Very Wide Frequency Range Marks This Novel Device

A PHONOGRAPH pickup which works on an entirely new principle has been announced. That principle is *torsional magnetostriction* — the variation of magnetic reluctance in a magnetostrictive wire when subjected to torsional stress in the presence of a magnetic field.

Magnetostriction is that property of certain ferromagnetic metals, such as nickel, iron, cobalt and manganese alloys which cause them to shrink or expand when placed in a magnetic field. Conversely, if subjected to compression or tension the magnetic reluctance changes, thus making it possible for a magnetostrictive wire or rod to vary a magnetic field in which it may be placed. This is true for lateral as well as longitudinal strains, and on this principle the magnetostriction pickup works.

If the ends of a ferromagnetic wire are fixed and a twisting motion applied to the center, in either direction, the twist will be equal on both sides. This may be demonstrated by holding a strip of paper, about one inch wide by twelve inches long, by the ends. Have someone grasp the strip at the middle and twist gently in each direction. Note that the amount of twist on either side of center is equal and increases as the angle of rotation is increased. This is illustrated in Fig. 1-a.

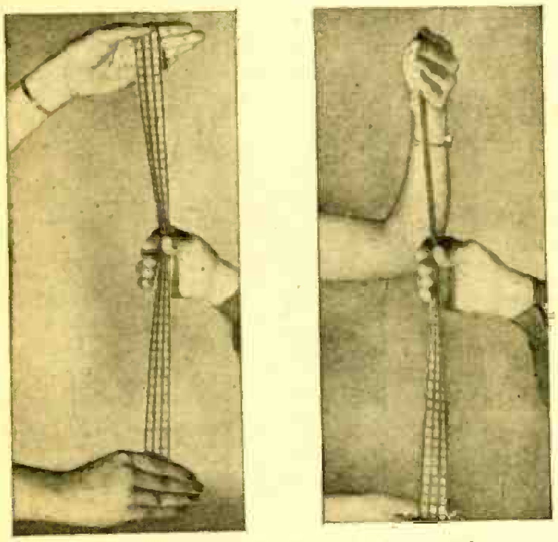

Fig. 1-a, left. Tape straight. Fig. 1-b, right—90° angle.

If, as in Fig. 1-b, the same strip is first twisted 90 degrees and the ends secured, a twisting motion at the center will increase the amount of torsion in one half the strip and reduce it in the other. One half the strip will be twisted still farther than 90 degrees, while the other will tend to return to its straight state. The wire used in the magnetostriction pickup is similarly twisted through 90 degrees, the ends looped and the wire secured in a magnetic field.

DETAILS OF THE PICKUP

A practical pickup is shown in exploded form in Photo A. A permanent reproducing stylus is fastened securely at right angles to the center of a piece of nickel or other magnetostriction wire. Two pickup coils, each wound with 100 turns of fine wire, are placed over the magnetostrictive wire on each side of the stylus. The ends are then looped over themselves and the wire given a slight twist and fixed between the poles of a horeshoe magnet. The wire is held in place and prevented from untwisting by looped ends that fit snugly into slots in the poles of the magnet as shown in the photo.

With the twisted wire in place, any motion of the stylus will cause the halves of the wire to twist in the same direction but the previous 90-degree twist will cause the torsion on one half of the wire to increase as that on the other half decreases. This twisting and untwisting motion in the halves of the wire will increase the leakage flux factor around one coil and reduce it around the other. It is this varying magnetic field that causes voltage to be generated in the pickup coils.

Since the change in flux is opposite in each half of the wire, it is necessary to connect the coils in what would normally be series-opposing. With the coils so connected the output voltage is the sum of the voltages in each coil. This connection also makes it possible to take full advantage of the even-harmonic cancellation characteristics of push-pull operation. This effect is shown graphically in Fig. 2.

The TM pickup, shown in Photo B, has an impedance of 4 ohms and is capable of generating .086 volt across a 100,000-ohm load. It is capable of reproducing frequencies *up to 26,000 cycles*, far beyond the human ear's ability to hear! Over the range of both commercial recordings and high fidelity transcriptions, the torsional magnetostriction pickup's response is uniformly true. While the sound frequencies of most commercial recordings are limited to a maximum of about 6500 cycles, and transcriptions to about 12,000 cycles, the high fidelity of the new pickup war-

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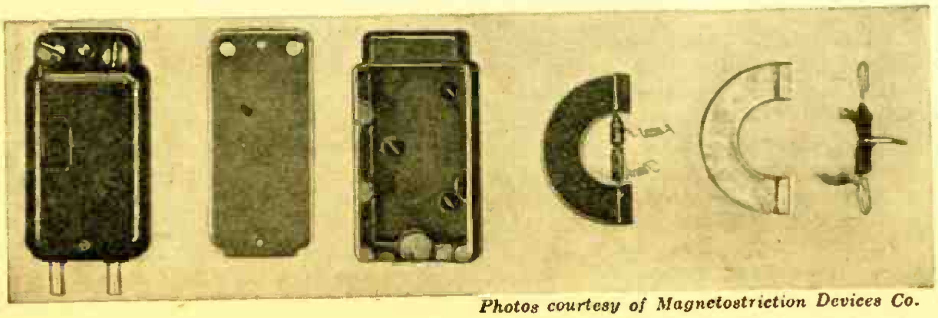


Photos courtesy of Magnetostriction Devices Co.

Photo A—Exploded view of the pickup. The important working parts are shown at right.

Photo B—Magnetostriction pickup in its case.

By GEORGE W. SCHULTZE

HOME INTERCOMMUNICATOR

An Efficient Set for Residential Use

The central control station in its cabinet.

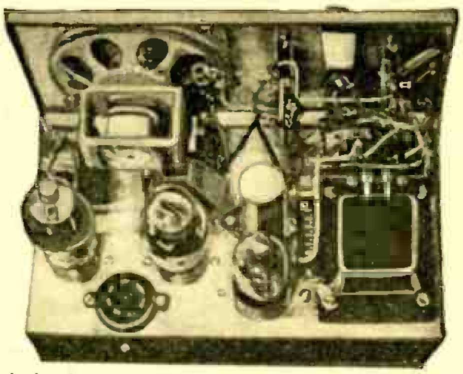
THE business or industrial intercommunication system is often extensive and expensive.

To justify a home installation, certain limitations and requirements must be recognized. The system described was developed to satisfy the following criteria:

1. Cost of the installation must be kept to a minimum. In most instances a home "intercom" or "squawk-box" falls in the luxury category, and the economics of the situation must be treated in that light.
2. The amplifier must be able to respond instantly with almost no warming-up wait, but at the same time must be economical on tubes and power.
3. The substations must be able to call the master station by voice rather than by signal to allow announcements to be made without waiting for a reply. Any substation operator may talk to the master station on his own initiative, but need not be able to contact other substations. The master station may hold a conversation with any one of the substations.
4. Amplifier and speakers must be capable of transmitting speech to and from a point somewhat removed from the speaker. That is, the system must be able to transmit intelligence even though the user is several feet from the station.
5. Interstation wiring must be as simple as possible, to avoid excessive material and installation costs. This means that high voltages and the need for shielded conductors must be eliminated.

A PRACTICAL SYSTEM

The original installation consists of a master station and three substations. Any number of substations can be installed, and additional ones can be placed in the system at any time. The master station is located in the "boss'" bedroom, while the substations are installed in "Granddad's" room, the kitchen, and the basement shop. The wire length from the master set to the most remote station is about 100 feet.



A back view of the central control station.

The circuit diagram, Fig. 1, shows a conventional two-stage audio amplifier with a 6C6 tube resistance-coupled to a type 41. Many other tube combinations will suggest themselves, but the one given is quite satisfactory. The input transformer T2 can be a conventional output transformer. The author used a compact surplus unit about which nothing is known except that it works well. The condenser C7 bypasses strong radio broadcast signals picked up by the interstation wiring. The capacity value of this condenser is not critical, but without it, the author's amplifier reproduced a twenty mile distant fifty-kilowatt program very nicely (but undesirably) with S2 in the "listen" position.

Also across the primary of T2 is placed R8. This was found necessary to eliminate the loud "beep" from the master station speaker when, on throwing the power switch to OFF, S4 is opened and the filter condensers momentarily supply B-voltage. R8 in the author's set is 1000 ohms. No decrease in signal volume was observed because of its insertion. It was found that a resistor of about 30,000 ohms across the secondary of T2 achieved the same results.

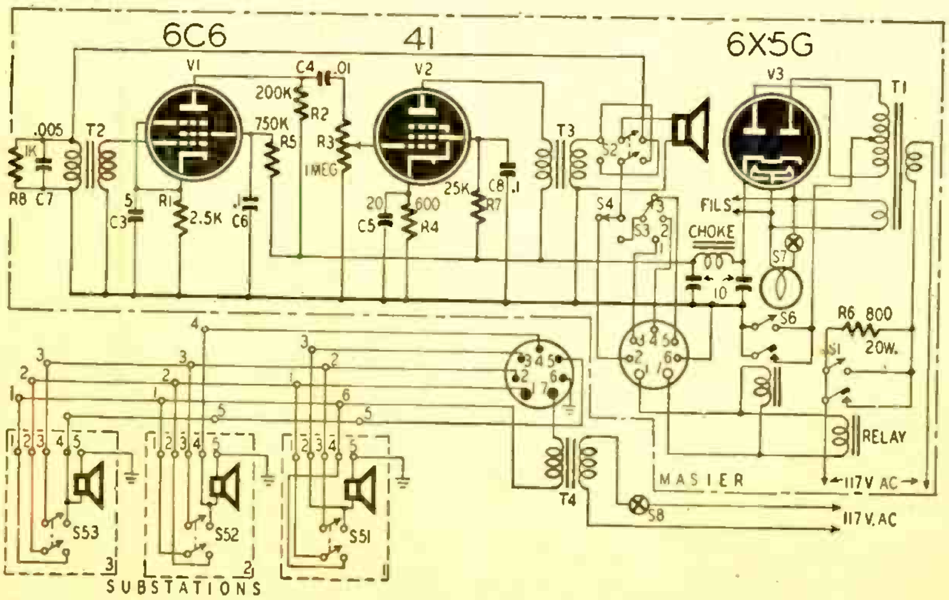


Fig. 1—Schematic of the central control station, substations and the switching system.

THE SWITCHING SYSTEM

The input circuit within the amplifier was wired with shielded conductor to eliminate objectionable feed-back. T3 is a conventional output transformer. The permanent magnet speakers, which also double as microphones, are preferably all identical. The ones shown in the photos are 4-inch, a compromise between compactness and reasonable response. The talk-listen switch, S2, allows switching the speakers from the speaker function to the microphone function at the will of the master station operator. S2 is a double-pole double-throw lever action switch with spring return. It is arranged so as to be normally in the "listen" position.

The power supply uses about the smallest standard line transformer available. A 6X5-GT rectifier was used in the original outfit, but an 80 or a 5Y3-G would be satisfactory. An a.c.-d.c. type power supply was ruled out because of the positive grounding of the amplifier B-minus. The rectifier circuit is conventional, giving a B-plus voltage of 310 d.c. In one of the primary

(Continued on page 55)

By McMURDO SILVER *

A PRECISION INSTRUMENT

Laboratory Accuracy in a Serviceman's C/R Bridge

IN the early days of one- to five-tube battery receivers with usually but a single function per tube and circuit, location and correction of troubles was simple indeed. The exact reverse is true today, for even the simplest type of five-tube broadcast receiver has several multiple-function tubes, each function having its own separate circuit and set of component parts. Most important is that each one of these circuits—and there can be many indeed in a complex modern receiver—employs a large number of individual capacitors and resistors. Even partial failure or alteration in value of but one of the many unimportant-appearing little capacitors or resistors can—and usually does—cause the poor performance which the technician is employed to correct.

Drawing upon his thirty-five-odd years of experience in the design of high-quality radio receivers as a guide to the precise types and forms of measuring equipment which can most effectively serve the serious maintenance technician, the writer has recently completed a piece of measuring equipment going far beyond the rough approximations heretofore available at low cost. It has been his goal to bring to the maintenance profession those orders of accuracy heretofore available only in laboratory instruments costing several hundred dollars or more, and hence beyond reach of most service organizations.

* 1249 Main Street, Hartford, Connecticut

If, in the design laboratory, it has been necessary to measure resistors and capacitors to an accuracy of a few percent, then it is obviously desirable that the maintenance technician be able to do likewise. Excellent approximations of resistance values may be made by a well designed and built ohmmeter. Capacity may not be so measured accurately, for *two values* enter into capacitance measurements—actual capacitance in microfarads or micromicrofarads, *plus power factor*. Considering only resistance measurements for a start, the good ohmmeter cannot be particularly accurate over much of its range because of the characteristic slope of its meter scale. The usual ohmmeter scale is "open" over its lower half and its accuracy can be excellent over this portion of its scale. Over the upper half, however, the scale graduations become increasingly crowded, since they must reach practically infinity at full-scale. Allowing for the normal and usual ±2 percent accuracy of even the best meters, a glance at the upper half of the ohmmeter scale in terms of graduation crowding versus such meter variation shows why high accuracy cannot be anticipated. It is true that this condition can largely be set at nought by provision of such a multiplicity of resistance ranges that it is seldom necessary to use the crowded high end of the scale in practice. Nevertheless, the really accurate method of measuring resistance is by means of the Wheatstone Bridge—the ohmmeter serves an essential function but for truly accurate measurement the bridge is a "must".

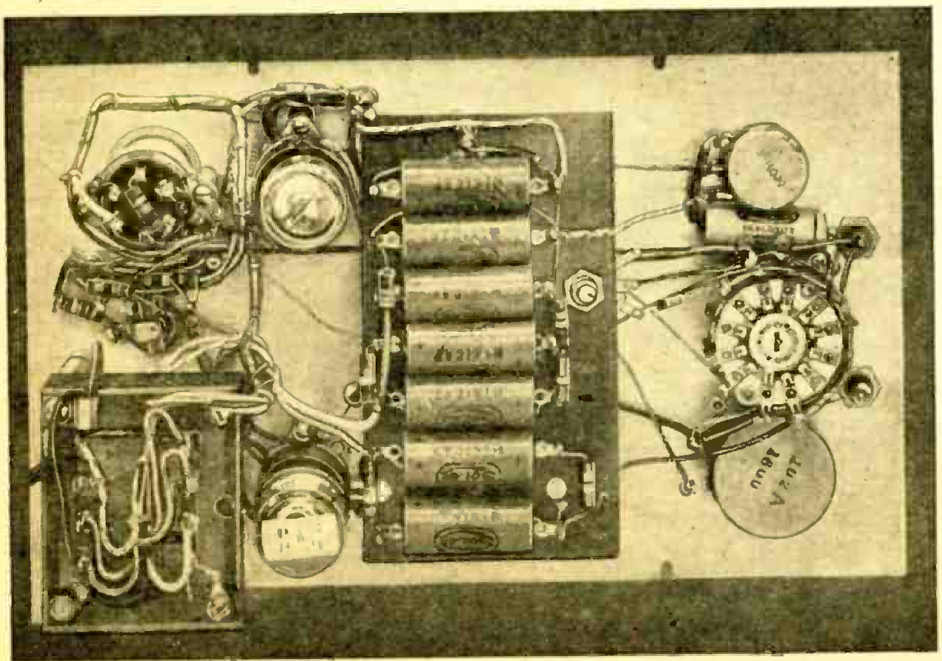
SUPERIORITY OF THE BRIDGE

It is true that an ordinary a.c. voltmeter or ammeter can be used to measure capacitance in the usual ohmmeter manner, but what actually happens is that the technician measures *capacitative reactance* which is then translated into capacity in terms of that capacitance which exhibits a given capacitative reactance at the particular a.c. frequency of measurement. Such attempts at measurement of capacitance cannot be more than approximately useful, since they ignore power factor. It is possible to find a capacitor apparently quite satisfactory so far as capacitance goes, yet have this capacitor exhibit such a high power factor as to be operatively useless. The fundamental Wheatstone Bridge method permits measurement of both capacitance and power factor, and so is a prime essential to the serious technician. Such a bridge may be so designed that it can provide resistance measurements with accuracy far exceeding the ohmmeter method, hence is most desirable.

One of the disadvantages of bridges so far available to the service technician is not alone that their accuracy left much to be desired because of low-cost components and the cursory test and calibration necessary to yield a low final selling price, but their lack of range as well. The equipment designer and the maintenance technician alike must be able to measure down to a fraction of an ohm, a fraction of a micromicrofarad—as well as up toward 1000 megohms and 1000 microfarads. Small compression mica trimmer capacitors—even air trimmers—of extremely low capacity can be causes of trouble and so must be capable of measurement in any well-equipped shop. Low values of resistance measurement are also necessary when "shooting trouble" in auto radio primary circuits, a.c. receiver heater circuits and the like. High ranges of resistance must be accurately determined in grid leaks and performance-impairing circuit leakage, while high values of capacitance appear in the filter capacitors of battery eliminators for portable battery sets as well as in "a.c., b.c. and d.c." sets themselves.

PRACTICAL PRECISION BRIDGE

The capacitance-resistance bridge illustrated and diagrammed covers the direct range of 10 ohms through 1000 megohms and 10 μμf through 1000



The careful wiring essential to a capacitor bridge is illustrated in this back-panel view.

μf. This is not its real range, for in operation it reaches down to ¼ ohm and ¼ micromicrofarad—low enough to cover compression mica trimmers and high-resistance or faulty connections in auto radio heater and vibrator input circuits, where high current requirements necessitate low circuit resistance. Values of unknown capacitances and resistances below 10 μμf and 10 ohms are measured and indicated directly, as the increment such low values add on the bridge dial when they are shunted across some convenient small value of capacitance or resistance first connected to the bridge terminals and measured. With a 10 μμf capacitance (conveniently provided by a pair of wires twisted together just sufficiently to give a 10 μμf indication on the bridge) it becomes possible to measure accurately capacitances as low as ¼ μμf. The same is true for resistance, substituting a 10 ohm resistor for the 10 μμf test capacitor.

Power factor of capacitors in the ranges usually made up of paper, oil and electrolytic structures should be measurable up to 50 percent. Since paper capacitors seldom are made below .001 μf, and as mica, ceramic and air capacitors seldom exhibit poor power factor without complete failure, we may establish power factor measurement as essential in the range of .001 μf up through 1000 μf.

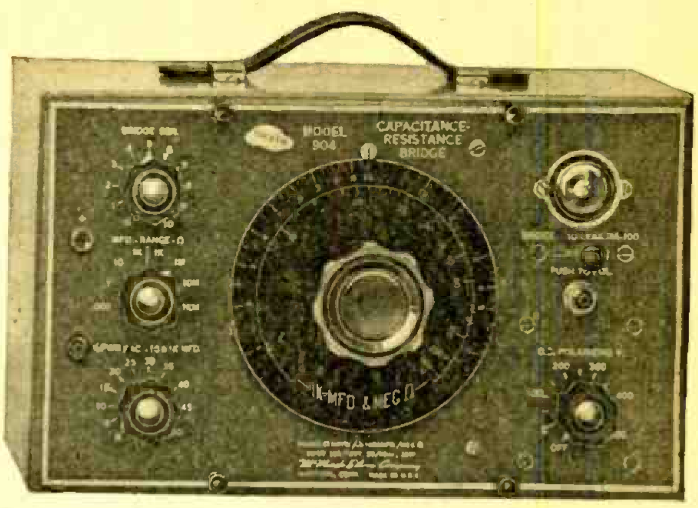
For electrolytic capacitor measurement and reforming after idle periods the ideal bridge must incorporate a source of continuously variable d.c. potential which may be applied to any capacitor under test. Provision must be made for determination of leakage currents through electrolytic capacitors as well.

If we can provide means for measuring condenser capacitance under conditions where actual d.c. operating voltages are applied at the same time that capacity is being measured, we may locate those intermittent condensers which are the bane of the service technician; condensers which test correctly out of circuit but which fail to function when restored to the equipment from which they were disconnected because a d.c. potential not present in outside measurement is reapplied to them.

Fig. 1 and the photos illustrate and diagram a capacitance-resistance bridge satisfying all of the requirements set forth above, a precision measuring instrument yielding an accuracy in measurement of capacitors and resistors of ±3 percent nominally over the range of ¼ μμf or ohm up through 100 μf or megohms; with such laboratory order of accuracy falling off slightly only between 100 and 1000 μf or megohms. Using it, power factor may be accurately determined, polarizing voltages may be applied to any and all types of capacitors during actual capacitance measurement, leakage currents in two ranges of 0-10 and 0-100 ma may be measured—even insulation resistance up to 1000 megohms with 0 to 500 volts d.c. applied may be accurately determined.

Operation is simple as it is accurate. The power cord plug inserted into any 105/125 volt, 50/60 cycle a.c. mains outlet, the bridge is turned on by moving the lower right knob from OFF to ON, and tubes allowed to warm up. Middle right lever switch set to BRIDGE, it is only necessary to connect an unknown resistor or capacitor to the two left panel jacks by means of the clip leads supplied and set RANGE knob to that position which allows the electron-ray tube to open to a maximum for some setting of the 5-inch dial, when the value of the unknown is read directly from the dial setting multiplied by the indicated RANGE knob figure. The upper left knob allows adjustment to the degree of "eye" opening which yields most accurate readability. The lower left knob reads power factor directly in percent at that setting which, after the bridge is balanced, yields greatest farther opening of the "eye." D.c. polarizing voltage is applied in accordance with the rating of the capacitor under test by appropriate setting of the lower right knob and depressing of the button-switch immediately above it. Capacitor leakage current is read on the "eye" as the percentage of closure it exhibits when the lever switch is thrown to the 10 or 100 ma leakage positions with polarizing voltage applied. No eye closure indicates no leakage current; full eye closure indicates 10 or 100 ma leakage current, depending upon lever switch position.

Fig. 1 illustrates circuit-wise how all of these functions are incorporated in an instrument measuring only 12⅝ inches long, 7⅝ inches high and 6 inches deep over knobs, in a weight of but 10 pounds, and all with large and costly laboratory instrument accuracy. The actual bridge measuring circuit itself consists of a 4-arm Wheatstone Bridge circuit in Carey-Foster form. The main dial controls the ±2 percent precision potentiometer P1 which constitutes two simultaneously variable arms of the bridge. A third bridge "arm" is always the unknown, or X, connected to the INPUT terminals. The fourth, or "standard" arm consists of C1, C2 or C3 for three capacitance ranges, or of R1 R2 or R3 for three resistance ranges. To obtain the two special high ranges of 10 to 1000 μf or megohms, special "expanding" resistors R4, R4a are cut into circuit at one or the other end of P1 by the range switch S1, S1a, S1b. Standard resistors are held to ±1 percent accuracy; capacitor standards, of mica and special mineral oil construction, to ±2 percent.



Front view of the Silver Model 904 Capacitance-Resistance Bridge.

This type of bridge circuit wherein two arms are varied simultaneously and oppositely in value yields the advantage of a 100 to 1 range for each rotation of P1, plus the desirable logarithmic scale calibration wherein accuracy is substantially constant percentage-wise at low, medium or high settings of the dial scale. It also lends it-

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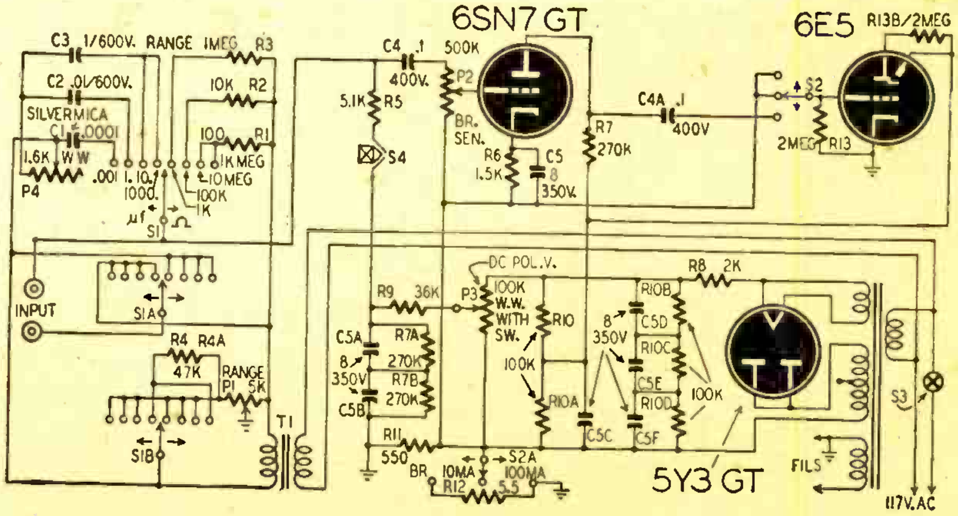
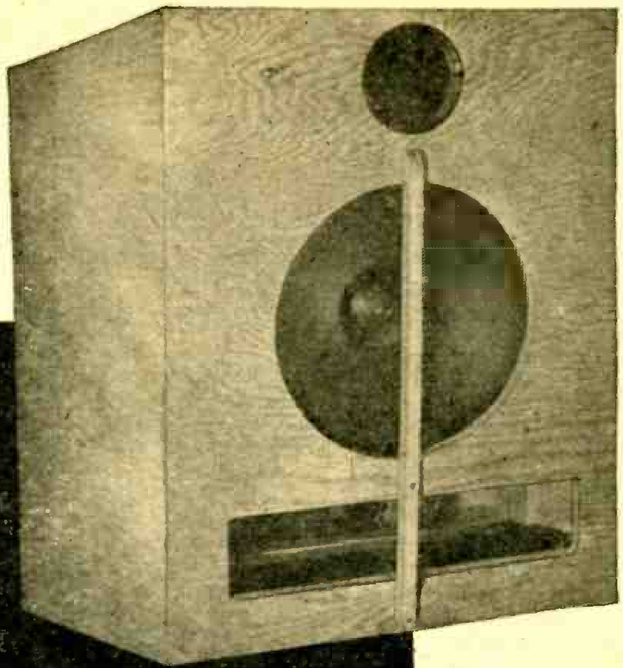


Fig. 1—Complete schematic of the bridge. Measurements are made with three main controls.

SOUND SYSTEM IMPROVEMENT

By J. CARLISLE HOADLEY



The speaker cabinet. Position and comparative sizes of vent and speaker hole are clearly shown here.

Excellent reproduction of recorded music depends on three factors: compensation for recording characteristics, a good amplifier, with special attention to the output transformer, and a speaker and baffle system which turns the output to sound with a minimum of distortion

A NUMBER of years' experience building maximum-fidelity amplifiers and sound systems have led to the formulation of a set of rules, which, if followed, will enable the listener to realize the best from any sound system.

First and foremost, the psychological factor must be considered. People are definitely different in their tastes and desires, and these desires change with the type of program they are listening to. Your amplifier should be equipped with some means of varying its response curve, preferably with independent treble and bass controls.

It is often stated (and rightly so, if the statement is qualified) that a *flat amplifier* is ideal. If we had a flat microphone, a flat amplifier and a flat speaker, located in a perfect acoustic chamber, and if the speaker output were exactly as loud as the sound source, the system would indeed be ideal.

Even with this theoretically perfect sound system, if we turned the volume down to one-half the loudness of the sound source, it would no longer sound like the original, because we have introduced a new variable, our ears. The human ear's response curve varies with loudness. The lower the volume the less ability there is to hear very low and very high frequencies.

Room acoustics have a profound effect on the ultimate sound of a system, and as there are few ideal rooms outside of broadcasting stations or laboratories, this is another item to be reckoned with. In addition to these things, few pickups, speakers and microphones are flat.

FREQUENCY RESPONSE

Now that we have an idea of what we have to contend with, let's get down to cases. Though the frequency response of a system is important, the most disturbing element in any system is distortion. This will be more apparent at the higher frequencies, so we limit the frequency response of the system till it is just sufficient to reproduce the material on hand. There is no advantage in using a system flat from 20 to 20,000 cycles to reproduce a shellac pressing. The high frequency noise and distortion would be unbearable. Neither could we use an inexpensive phono motor with this wide-range system without the rumble in the motor being very apparent. So-called permanent needles when worn cause a particularly annoying type of distortion, in addition to causing permanent damage to the records.

The response of an AM receiver need not be any wider than 40 to 5000 cycles for the average station when broadcasting network programs, and 30 to 9500 cycles is entirely satisfactory for the best AM stations when broadcasting local programs. Limiting the response to 9500 cycles is to suppress any 10-kc beats between other stations located 10 kc apart. For FM reception or transcription reproduction we can go the limit and provide response from 30 to 15,000 cycles, for only in these sources is the distortion low enough or the range wide enough to warrant this wide range.

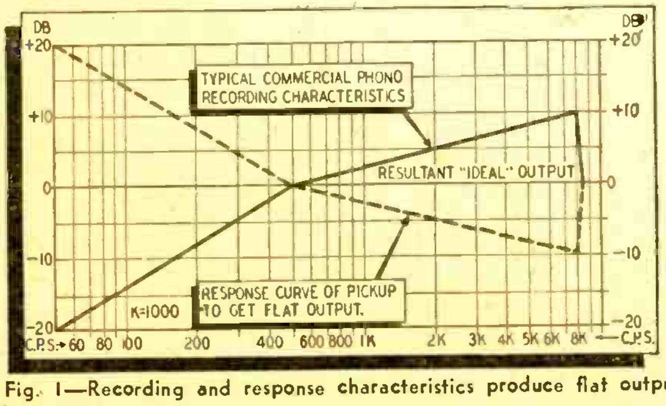


Fig. 1—Recording and response characteristics produce flat output.

In the reproduction of any record we must take into account the various recording characteristics and compensate the pickup accordingly. Standard shellac phonograph records are recorded with a "modified" velocity characteristic. Amplitude of the cutting stylus is held constant from the lower frequency limit to between three and eight hundred cycles, and modified constant-velocity above this crossover frequency provides a five to ten decibel boost at 8000 cycles. See Fig. 1.

This is done for the following reasons:

1. Due to widespread use of crystal type pickups, the manufacturers of records insert a high frequency boost to reduce the compensation necessary to flatten the playback equipment's response. This boost effects a considerable improvement in signal to noise ratio.

2. A large majority of the users of shellac pressings have equipment with serious attenuation of the higher frequencies and no means for the compensation thereof. As the figure shows, there is a falling-off at the low-frequency end of the audio spectrum. If the low frequency amplitude were not restricted, either overcutting would result or the level of the high frequencies would be below the noise level.

PICKUP CHARACTERISTICS

If constant velocity records (without treble boost) are played back with a magnetic pickup the output will be flat with decreasing frequency down to the crossover frequency where constant amplitude begins. Since the magnetic pickup requires successively greater stylus motion at the low frequencies to maintain its output flat, and since the amplitude is held constant below the crossover frequency (300 to 800 cycles) we must provide an equalizer to compensate for this condition. Since practically all commercial records made in the last six or seven years have a treble boost, the magnetic pickup must be further compensated to *reduce* its high frequency response. Otherwise response from commercial records will be excessively brilliant. Fig. 2 shows the

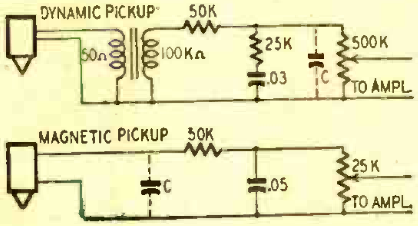


Fig. 2—Two suggested equalization circuits.

usual method of equalization. Constants are approximate and depend on the pickup and transformer, as well as the recording characteristic of the records being played. Condenser C is for treble attenuation. Its value may be anywhere from .002 to .02 μf, depending on the pickup and transformer.

A crystal pickup has a *constant amplitude* characteristic. Its output voltage is a direct function of stylus motion independent of frequency up to its high-frequency cutoff point. For constant velocity recording (without treble boost) above the crossover frequency we would have to compensate for the decrease in stylus amplitude with frequency. This is in the order of six db per octave above the crossover fre-

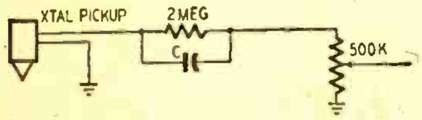


Fig. 3—Equalizer circuit for crystal pickup.

quency. To compensate the pickup for this would require considerable boost at 7000 cycles. However, commercial records insert treble boost at a rate of from two to about five db per octave above the crossover frequency, depending on the record. Thus for some records no high-frequency equalization is required and for others only a small amount. The customary method of compensating crystal pickups for commercial records is shown in Fig. 3. Reducing the value of C will reduce the amount of treble boost. For maximum boost C should be about .002 μf. When playing records having considerable treble boost, C should be reduced in value to as low as 50 μμf. Transcriptions are recorded with more involved response characteristics (generally they have considerably more treble boost than records) and the manufacturer of the pickup should be consulted for information on equalizers for Orthacoustic, NAB Standard, Columbia or other transcription characteristics.

THE AMPLIFIER

Now that we have a suitable flat source of music we wish to amplify it with as low distortion as possible. The easiest way to do so is to build a straightforward amplifier using triode tubes throughout. We can choose between 6A3, 6B4, 2A3, 45 for the output stage. These tubes should be arranged in push-pull, as the attendant cancellation of second harmonic distortion and supply-voltage hum is worthwhile, and reduces the first filter section requirements. Of course, beam tubes (6L6-6V6) can be used with feedback.

The most important purchase in connection with this amplifier is a good output transformer. It will make more difference than any other component. An output transformer may have a power rating of ten watts. This is somewhat deceptive as it is usually measured at some middle frequency, usually 400 or 1000 cycles. The same transformer may only be capable of transferring four watts at 30, and six watts at 12,000 cycles. This is a serious drawback particularly when we wish to boost the high and low frequencies. High-quality units are relatively inexpensive in comparison to the results they will produce.

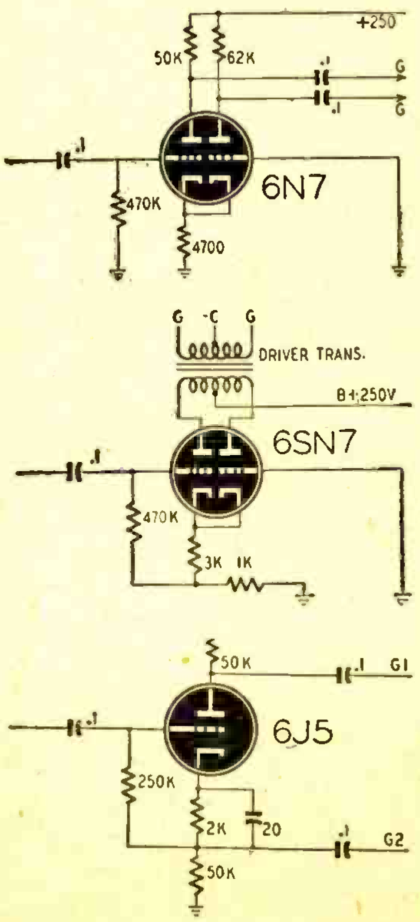


Fig. 4—Three self-balancing phase inverters.

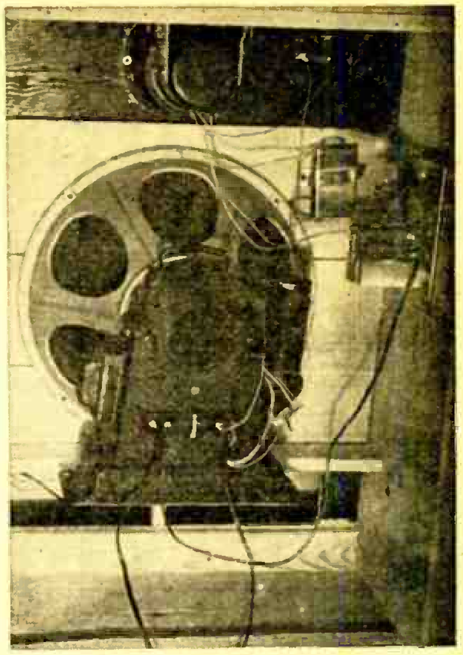


Photo B—Inside view of the speaker cabinet.

A high-quality output transformer for a 15-watt 6B4 amplifier can be obtained for $15.00 or so.

An input transformer need not be used if class-A operation is desired, as a phase inverter is adequate. Fig. 4 shows several inverters which are degenerative and consequently self-balancing and of the low-distortion type. If class AB or AB_2 operation to obtain maximum power output is desired, an input transformer is needed to keep the resistance in the grid circuits of these tubes low in the case of a small amount of grid current being drawn.

Fixed bias is desirable as it allows greater power output with lower distortion. Fig. 5 shows a simple way to obtain it when your power transformer does not have a bias tap. A separate transformer winding is required. The rectifier may be a triode similar to those in the amplifier.

If you use an input transformer it is wise in the case of an inexpensive unit and essential for a high quality unit, to shunt feed the primary from the driver tube. This does not hold for push-pull drivers, as their d.c. plate current balances out in the output transformer.

Be sure to bypass all cathodes with large enough condensers to eliminate degeneration at low frequencies. It is wise to decouple every stage, both in the interest of low hum level and to eliminate the possibility of motor boating or unwanted interstage coupling.

One should, of course, use as good a speaker as possible and it should be baffled efficiently.

A bass reflex baffle offers many advantages, among which are improved bass response, higher sensitivity and cleaner high-frequency response. The distortion at low frequencies may be reduced greatly over the conventional open-back enclosure.

When a speaker is placed in an en-

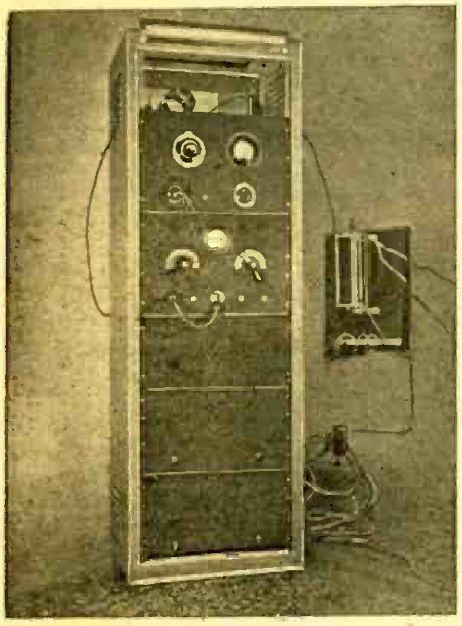
(Continued on page 52)

By HARRY D. HOOTON, W3KPX

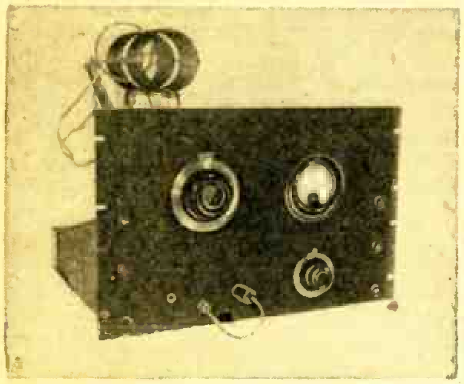
UNIVERSAL 1-KW AMPLIFIER

Tuning Up and Adjustment Are Completely Described

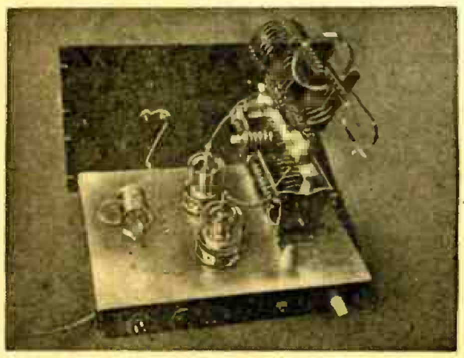
THE average amateur starts out with what appears to be a good r.f. final amplifier design *on paper* and by the time that the rig is completed and all of the "bugs" ironed out, usually winds up with an entirely different layout. Sometime later when the urge to try out a pair of the new pentodes, tetrodes or triodes, as the case may be, becomes unbearable, he is very much surprised and shocked to learn that, although the amplifier functioned perfectly with the previous tubes, it is again necessary to go through the entire "debugging" procedure with the new ones.



Amplifier is in the top section of this rack.



Closer view of the one-kilowatt final stage.



A rear view of the unit. Note swinging link.

The author spent his spare time over a period of several months in an intensive experimental effort to develop a simple and stable high-power r.f. amplifier design which would be suitable for use with practically *all types of* pentode, tetrode and triode tubes. It was also felt desirable that the number of mechanical changes required when going from one type of tube to another should be reduced to the minimum. A multitude of arrangements were tried, some of which were good from a mechanical viewpoint but lacked stability when used with several different types of tubes; others had good electrical stability but were difficult to construct. As might be expected, the resultant design is a compromise between the various factors involved; the practical working model amplifier is described in this article.

As the photographs and drawings show, the unit is built up on a 17 x 13 x 3-inch cadmium-plated heavy-duty steel chassis and a 12x19-inch aluminum panel. The chassis is mounted *spaced two inches from the aluminum panel*, which also gives a two-inch spacing between the rear of the chassis and the back of the standard cabinet when the door is closed. The purpose of the offset type of construction is: 1. to permit a symmetrical layout of the parts on the top of the chassis; 2. to allow the plate tank coil to be electrically balanced with respect to ground. The center lines of the chassis and the center lines of the Parmetal 66-inch metal cabinet coincide; therefore, the two "hot" ends of the tank coil are equidistant from ground when the cabinet door is closed.

This amplifier is designed to operate on the 3.5, 7, 14 and 28 megacycle amateur bands with practically any modern transmitting tubes such as the Eimac 100TH, 250TH, 4-125A or 4-250A; the Gammatron HK-54, HK-254 or HK-257B; or the Taylor TW75 or TW150. Using suitable tubes, the amplifier is easily capable of input powers up to 1,000 watts with excellent efficiency and stability. The only changes required when going from one type of tube to another are: 1. A filament transformer of the proper voltage and current capacity; 2. proper sockets for the tubes used; 3. incorporation of proper capacity and voltage rating neutralizing capacitors if the tubes are triodes.

GRID CIRCUIT ISOLATED

As shown in the under-chassis view photograph, the grid tank tuning condenser is mounted under the chassis. Experiments with previous amplifiers had convinced the author that much of

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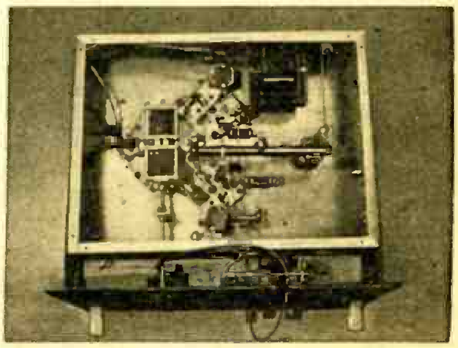
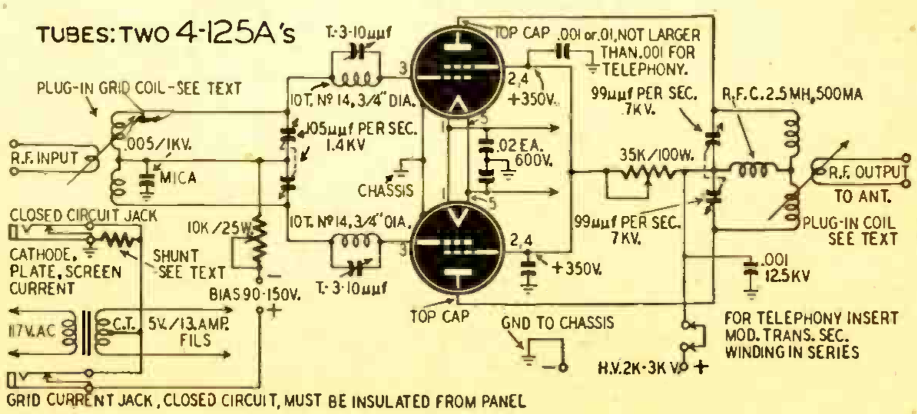


Grid tuning condenser is under the chassis.



Circuit is designed to accommodate tetrodes, pentodes and triodes, with slight adaptations.

By HUBERT W. WATKINS

SERVICING MOVIE SOUND

Maintenance and Repair of Sound-on-Film Systems

"THE show must go on." This is an honored tradition in the entertainment world. Vaudeville and stage actors often work while ill or bereaved to preserve this tradition. Today it is the watchword in thousands of moving picture houses in all parts of the country, from the smallest neighborhood movie to the most palatial urban theater.

The local radio technician can help uphold this tradition, at a profit for himself. He is readily available when sound trouble occurs and has the equipment, spare parts and knowledge to make either a permanent or temporary repair usually in a matter of minutes. The break may thus be limited to an absolute minimum, thereby saving the theater prestige and money that would otherwise be lost in refunded admissions.

Any radio technician who intends servicing theater sound equipment—either routine or emergency—should first notify the business agent of any union under which the projection booth may be operated and obtain his permission to enter the booth for that purpose. He should also ascertain that his servicing the equipment would not violate the terms of any contract the theater may have with a service organization.

SOUND-ON-FILM SYSTEMS

When sound was first brought to the screen it was in the form of 16-inch wax recordings. For each reel of film a corresponding wax record was necessary for the sound. This system had many disadvantages. The principal one was that of synchronization between picture and sound. Proper synchronization was dependent on placing the reproducer needle accurately at the start mark on the record and the film start mark in the picture aperture. This insured that picture and sound started in synchronization. However, if any film had been damaged and removed, synchronization did not exist from that point to the end of the reel. It became common practice to replace any damaged film with an equal length of black film in an effort to maintain synchronization.

This system has been replaced with sound-on-film recording. In addition to other advantages, it insures perfect synchronization between picture and sound at all times because the picture and sound are both printed on the film.

The sound is recorded approximately nineteen frames ahead of the picture; in projection this places at the scanning beam that point on the sound track which corresponds to the picture in the aperture at any given instant. The frequency and volume range that may be recorded on film is far greater than that possible with disc recording.

All sound-on-film may be broadly classified as variable-area, which is essentially an oscillographic trace of the signal currents (Fig. 1-a), or variable-density, which is a half tone photograph of the recorded sound (Fig. 1-b). Both operate on the principle of modulating a beam of light, which is made to pass through the sound track and on to the cathode of the photoelectric cell. The photo-cell converts the light variations into electrical impulses whose wave form corresponds to the recorded sound. These impulses are very feeble and must be amplified many times before they are strong enough to operate the speakers.

THE SOUND HEAD

It is extremely important that the film move past the scanning point at a uniform speed of *ninety feet per minute*. All traces of flutter or variations in speed must be absorbed so that it will not affect the movement of the film past the scanning point. This is accomplished by free-running loops on both sides of the scanning point. These loops absorb any flutter or sudden variations in speed. The film is pulled through by a constant speed sprocket (Fig. 2).

The rotary stabilizer or oil-damping wheel is used in later sound systems to

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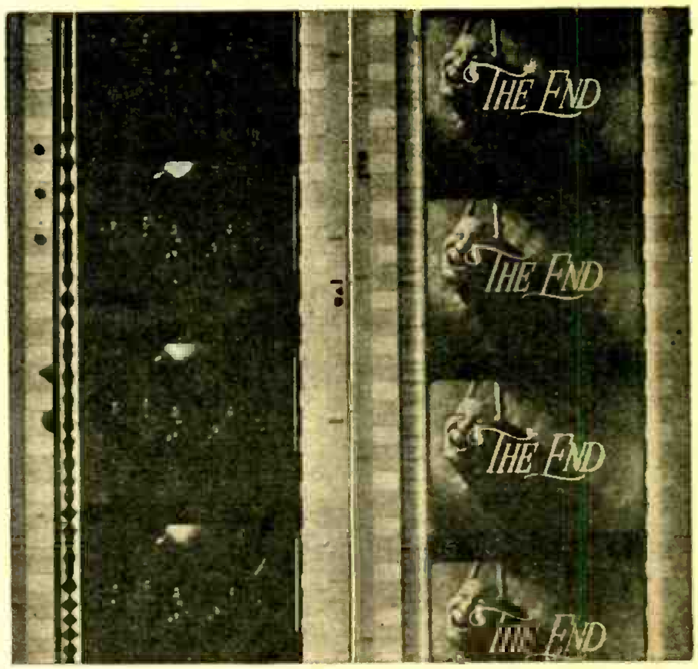


Fig. 1-a, left—Variable area; 1-b, right—variable-density strip

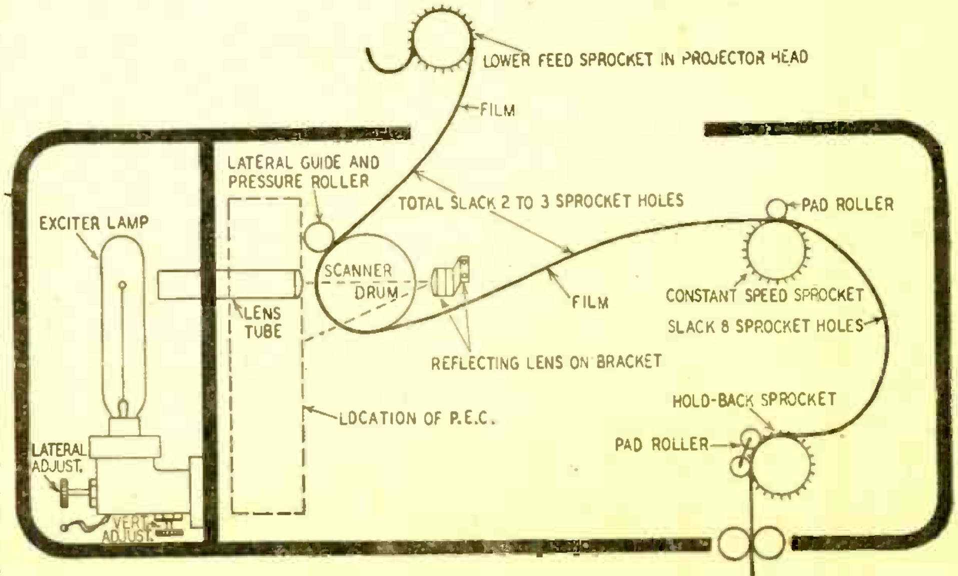


Fig. 2—Course followed by the sound film, showing how it is propelled and stabilized.

insure uniform film speed at the scanning point. This is simply an oil-damped flywheel which is not geared to the mechanism in any way, but is driven by traction between the film and the scanner drum, which is mounted on the same shaft with the damping wheel. Since this wheel is not geared to the mechanism, it is free of all variations in speed inherent to the mechanism.

The damping wheel should pick up—from a dead stop to full speed—in two to three seconds. A peculiar gurgling distortion which lasts from one to ten seconds after changing from one machine to the other is usually caused by this wheel not having reached full speed when change-over is made. This is caused by a worn or improper adjusted guide and pressure roller (Fig. 2). The obvious remedy is replacement or adjustment of this roller to insure proper traction between film and scanner drum.

The drum may be spun by hand to determine if it runs freely. The run-out should be smooth with no jerky or sudden stops. The deceleration time (from normal speed) is between thirty and sixty seconds. If it is much less than this or if the stop is jerky or sudden the bearings should be cleaned and inspected. The scanner drum should also be inspected for end play. If end-play exists the film will weave in its motion past the scanner, resulting in the light beam being modulated by the framing lines or sprocket holes. To remedy, remove the damping wheel and reverse one of the spring washers provided to absorb end play, or add another washer.

In the older sound systems the film is pulled through a sound gate by the constant speed sprocket. This sound gate exerts a slight pressure on the film which results in an even pull at the scanner. Mounted on the same shaft with the constant speed sprocket is a heavy flywheel, the inertia of which protects this shaft and its sprocket from flutter and variations in speed. Free-running loops are provided to isolate the scanner.

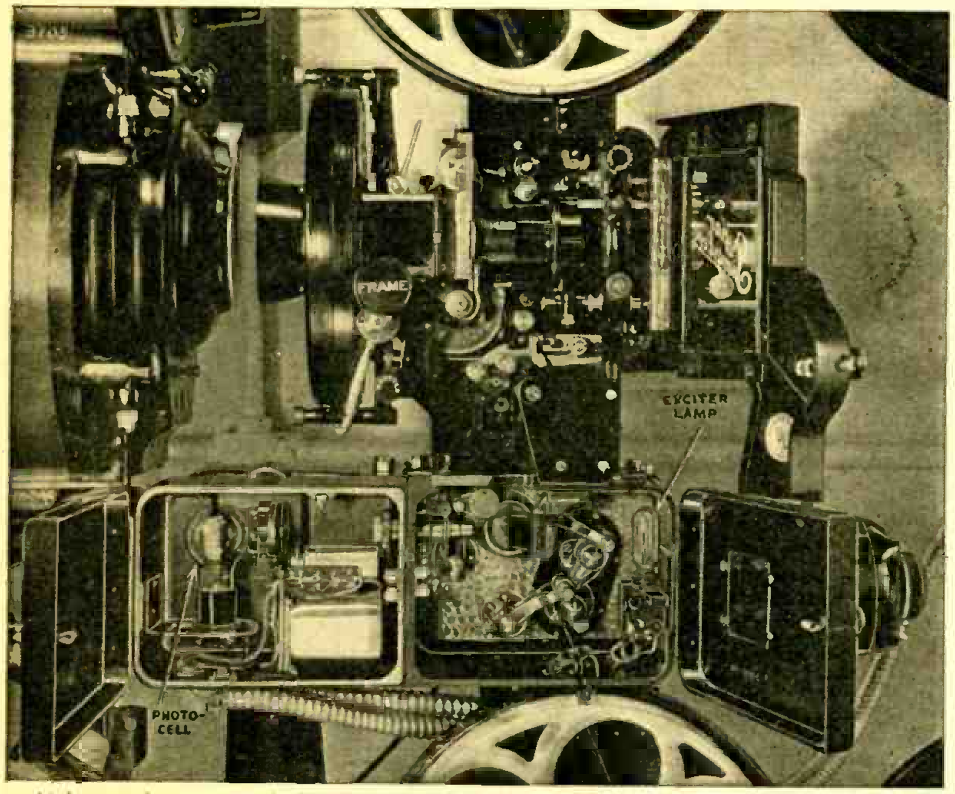
THE LIGHT SYSTEM

The exciter lamp and optical system should be adjusted so that it projects on the sound track a uniformly illuminated image approximately .084 by .0012 inch. Lateral and vertical adjustments are provided on the exciter lamp bracket, and it should be carefully adjusted so that it is in perfect alignment with the optical system. The volume and frequency response will be seriously affected if the inside of the glass envelope is blackened from use, or if the filament sags. In either case the lamp should be replaced and proper adjustments made.

The sound head must be *clean*. Tests show that a film of oil or dirt on any part of the optical system will seriously affect the high frequency response. The lens, mirrors, etc., should be thoroughly cleaned with lens tissue; all other parts of the sound head may be cleaned with a soft cloth.

Unless it is definitely known that the optical system is out of focus, no adjustment should be made. If adjustment is necessary, one of two methods, both using Academy 8000-cycle test film, may be used:

Thread the test film in the machine and—with the machine running—adjust the lens tube until maximum response is obtained from the amplifiers. This may be observed aurally or with an output meter.



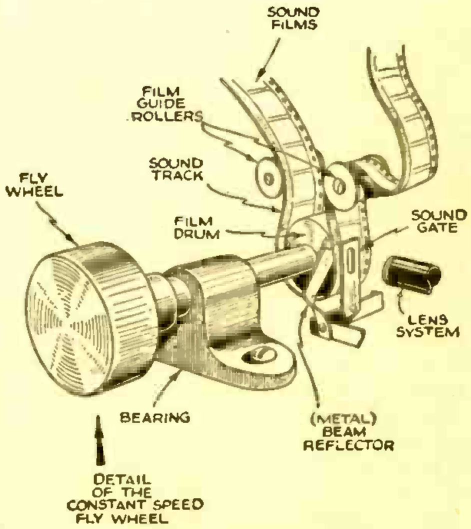
Light travels in a straight line from exciter lamp to photocell in this type of projector.

The second method of adjustment is known as the flicker test. A white card is placed between the film and reflecting lens. When the film is moved slowly, by hand, the frequency lines cause a definite flicker of light on the card. The lens is in focus when the lines appear to be stationary. If they appear to move up or down on the card, the lens tube should be adjusted.

In modern sound heads the lens tube is accurately adjusted for azimuth at the factory and it is not necessary to disturb this adjustment in order to focus the lens. This is not true in the older types because the lens tube is simply held in a clamp. If the locking screws are loosened the lens tube may be rotated as well as moved forward or backward. In fact it would be practically impossible to adjust the focus without rotating the tube slightly, and if any adjustments are made special care should be taken so that when the adjustment is finished the lens will be in focus and the image will be parallel with the frequency lines on the sound track.

If test film is not available, fairly accurate adjustments may be made by running any film with good sound recording and making adjustments for maximum high frequency response.

The lateral guide roller (Fig. 2), should be adjusted so that the scanning beam does not strike the frame lines or sprocket holes. The adjustment may be checked by running Academy Buzz Track film (which has a silent sound track with a low-pitched buzz recorded on each of the sound track border lines). Turn the adjusting screw clockwise until the buzz track can just be heard, then turn in the opposite direction, counting turns and fractions of turns, until the opposite side of the buzz track, which is a different frequency, can be heard. Turn the screw clockwise again half as many turns and fractions of turns as was required to bring the beam from one side of the



How lens, sound gate and mirror are placed.

track to the other. This centers the beam on the sound track.

If Buzz Track film is not available

(Continued on page 59)

By MILTON S. KIVER

TELEVISION FOR TODAY

Part VI — Contrast and Gain Control Systems

IN the standard radio sound receiver, volume is controlled by the volume control. In a television receiver, a comparable control is the contrast control and the intensity of the image is dependent upon its setting. Unlike the volume control, however, the position of the contrast control is usually in the grid or cathode circuits of the video i.f. amplifiers and very seldom at the input to the amplifiers following the detector, the point where most volume controls are located. Incidentally, another name for the contrast control is intensity control.

The action of the contrast control is simple. By varying the gain of the two or three stages to which it is attached, it controls the amplification supplied to the video signal. The more negative the bias of an amplifier, the lower its gain. With variable-mu tubes, the extent of control is very wide and the amplification factor may be varied over wide limits with only a slight effect on distortion. With sharp cut-off tubes, greater gain is possible, but the range of linear operation is restricted and distortion is readily produced.

Two simple methods of obtaining contrast control are indicated in the circuits of Fig. 1 and Fig. 2. In the former illustration, the power supply is designed so that a small negative voltage is developed across the 150-ohm (5-watt) resistor. This voltage is then applied across the 30,000- and 50,000-ohm resistors, with the variable 50,000-ohm resistor functioning as the contrast control. This negative voltage is fed to the 1852 mixer and 1852 1st video i.f. amplifier. Two 500,000-ohm decoupling resistors serve their usual function of isolating each circuit to prevent undesirable interaction. The .005-μf condensers complete the r.f. (or i.f.) path for the incoming signals.

The use of 1852 sharp cut-off tubes may appear to be a direct contradiction of a preceding statement until a closer inspection of both cathode circuits reveals 40-ohm unbypassed resistors. These partially counteract changes in input capacitance with changes in plate current, but they also serve to extend the E_g-I_p characteristic curves sufficiently to obtain limited remote cut-off properties. The advantage of this combination over an 1853 variable-mu tube is the higher G_m available with the 1852. The unbypassed cathode resistor reduces the G_m somewhat, but its overall gain remains higher than the 1853.

The second method of obtaining contrast control is given in Fig. 2. Both tubes are subject to a variable bias—in addition to small fixed biasing resistors—from the common 2,000-ohm potentiometer. The fixed cathode resistors set the minimum bias for each tube, while the additional bias serves for control.

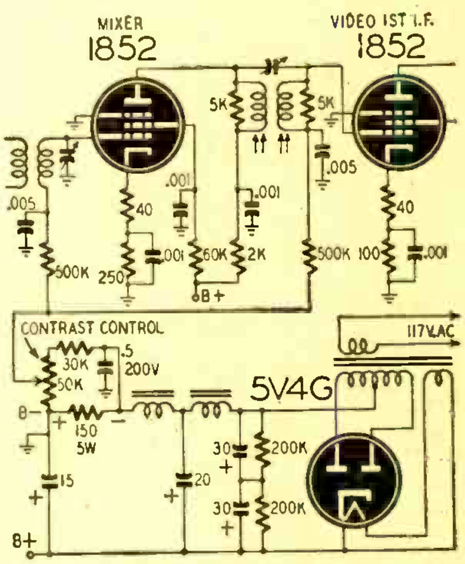


Fig. 1—Contrast control in Meissner receiver.

Designers seldom attempt to control more than three stages because of the possibility of introducing distortion in tubes where the level of the amplifier signal is high. The practice of including the mixer among the controlled stages has become common because of the separation of the oscillator and mixer operations. When both are within one envelope, the possibility always exists that a change in bias will produce a change in oscillator frequency. With the oscillator functioning as a distinct unit, this limitation is removed.

A final word about the contrast control. It controls the intensity and, indirectly, the contrast between light and dark values in the image. If the image is made intense, the difference between the bright and the dark portions of the picture will increase, which means that the overall image contrast likewise increases. On the other hand, a decrease in the setting of this control lowers the contrast ratio. Since the dark level of the image, where details are no longer distinguishable from each other, is relatively fixed, we see that the control is concerned mainly with increasing or decreasing the intensity of the brighter section of the image. It is as though one end of an elastic were held fixed, while

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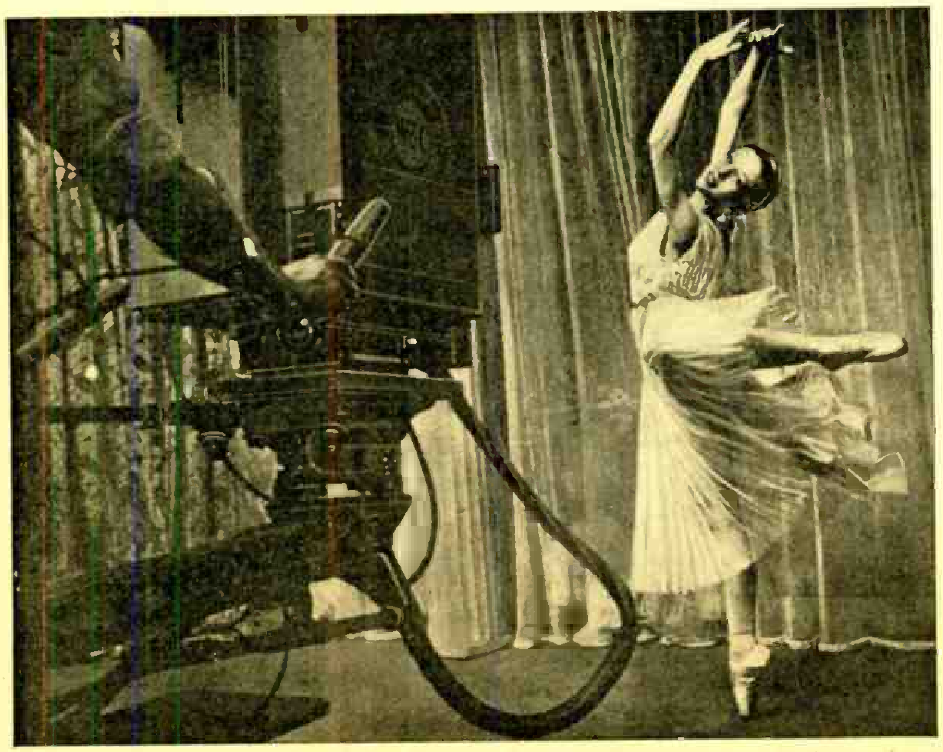
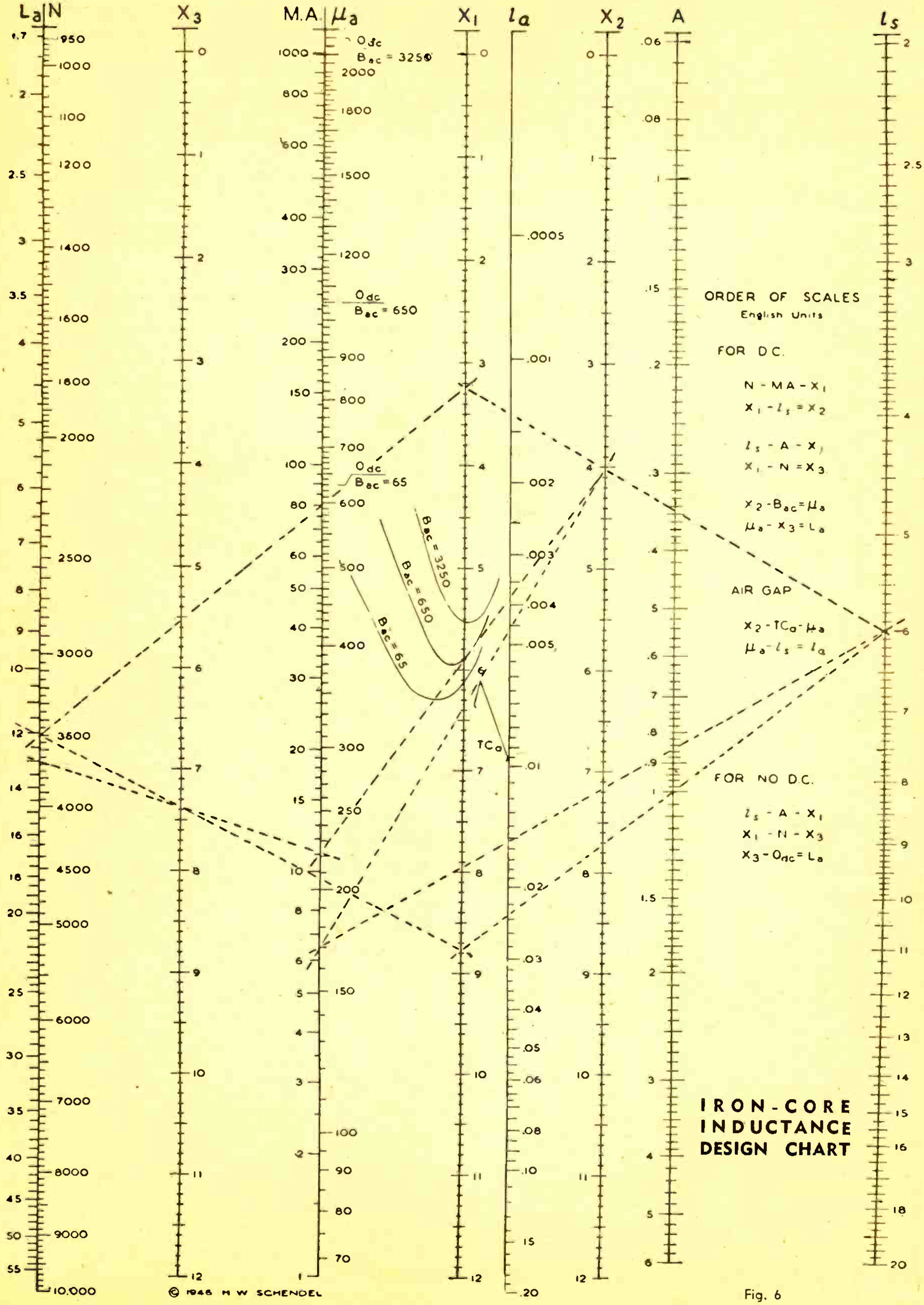


Studio lighting, camera work and direction are all important to the image in the receiver.



IRON-CORE INDUCTANCE DESIGN CHART

Fig. 6

By H. W. SCHENDEL

COILS, CORES AND MAGNETS

Part II—Reactor and Transformer Measurement and Design

FILTER chokes or reactors, audio frequency chokes, and audio transformers come under the classification of iron-core inductances. The unit of inductance is the *henry*. A coil has an inductance of one henry if a current changing at the rate of one ampere in one second induces one volt in it.

Basically inductances are the same as electromagnets and use cores like the relays described in the first part of this article. The essential difference is that inductance is the main consideration. This in turn depends on the permeability of the steel or alloy.

Considerable care is required in rewinding good grade audio devices but it is a comparatively simple matter to rewind filter chokes and obtain approximate original characteristics. If a unit is rewound with original size wire, with about the same number of turns, and close attention given the size of air gap, if any, no trouble should be encountered. *When an air gap has been used its size is extremely important.* In some cases a change of .001 inch in air gap total length will cause a 50 percent change in final inductance. Generally speaking it is better to err slightly oversize rather than undersize.

Much valuable information on rewinding, including a copper wire table, appeared in articles in the Aug.-Sept., October, and December 1942, and the September 1943 issues of RADIO-CRAFT.

To rewind an iron-core inductance for other than original conditions or to design one for some specific purpose involves several factors.

Windings of iron-core coils carrying only a.c. have an inductance which varies in relation to the induced flux in a manner similar to the variation of the d.c. permeability obtained from Fig. 1, which appeared last month. Push-pull output transformers in which the d.c. effects cancel and interstage transformers which have the d.c. blocked from their windings are examples of the simple a.c. class.

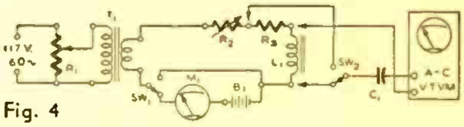


Fig. 4

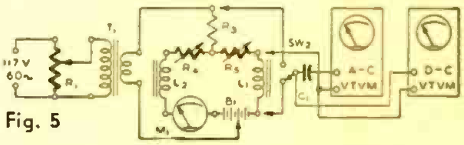


Fig. 5

R1—500-ohm, 100-w rheostat
R2—D.c. rheostat
R3—Non-inductive shunt resistor
R4,5—Two similar rheostats
C1—1-uf (or more) paper condenser
Sw1, 2—S.p.d.t. switches
L1—Iron-core inductance (under test)
L2—Iron-core inductance (like L1)
T1—Power transformer (heavy duty)
M1—D.c. milliammeter for range needed
B1—Battery, adjustable-voltage with center tap

Most iron-core inductance windings carry both a.c. and d.c. simultaneously—a.c. superimposed on d.c. As either of these may be varied in magnitude it is easy to see there would be an almost endless number of conditions, each resulting in a different inductance. The inductance rating of any device is accurate *only when the test conditions are the same as the normal load conditions.*

Curves may be prepared showing the a.c. flux density ($B_{max\text{-}ac}$) versus a.c. permeability (μ_{ac}) for various values of d.c. in the winding. Such curves prepared from test data on a special test core are called *incremental permeability* curves.

Due to the factors explained in connection with d.c. magnetization curves as well as other factors—eddy-current insulation, stacking factors, core shapes and sizes, and other characteristics of laminations — separate permeability curves are needed for each core design. The curves, when prepared from data obtained directly from a definite working design, using a specified steel or alloy, are called *apparent permeability* curves (μ_a). They indicate the actual permeability (not theoretical) which the design appears to have under selected working conditions.

An air gap is seldom used when the inductance is used only on a.c. except in such devices as fluorescent lamp and sunlamp ballasts. Lamp ballast design

(Continued on page 72)

SYMBOLS	ENGLISH UNITS	C.G.S. UNITS
M.M.F. (MAGNETO MOTIVE FORCE)	= NI = RØ (IN AMPERE TURNS)	= 0.4πNI = RØ (IN GILBERTS)
R (RELUCTANCE)	$= \frac{MMF}{\phi} = \frac{NI}{\phi} = \frac{l}{3.19\mu A} = \frac{1}{P}$ 0.313 FOR 1 CU. IN. OF AIR	$= \frac{MMF}{\phi} = \frac{0.4\pi NI}{\phi} = \frac{l}{\mu A} = \frac{1}{P}$ 1. FOR 1. CU. CM. OF AIR
Ø (MAXWELLS, FLUX, OR LINES OF FORCE IN ANY MATERIAL)	$= \frac{NI}{R} = \frac{3.19\mu NIA}{l} = \frac{MMF}{\frac{l_s}{3.19\mu A_s}\ \frac{l_a}{3.19A_a}}$	$= \frac{0.4\pi NI}{R} = \frac{0.4\mu\pi NIA}{l} = \frac{MMF}{\frac{l_s}{\mu A_s} + \frac{l_a}{A_a}}$
Ø (SAME AS ABOVE BUT FOR AIR)	$= \frac{3.19NIA}{l} = \frac{NIA}{.313l}$	$= \frac{0.4\pi NIA}{l}$
P (PERMEANCE)	$= \frac{\phi}{MMF} = \frac{\phi}{NI} = \frac{3.19\mu A}{l} = \frac{1}{R}$	$= \frac{\phi}{MMF} = \frac{\phi}{0.4\pi NI} = \frac{\mu A}{l} = \frac{1}{R}$
NI (AMPERE TURNS FOR ANY MATERIAL)	$= \frac{H\phi l}{BA} = \frac{\phi l}{3.19\mu A}$ = AMPERES X TURNS	$= \frac{H\phi l}{0.4\pi BA} = \frac{\phi l}{0.4\pi\mu A}$ = AMPERES X TURNS
NI (AMPERE TURNS FOR AIR)	$= \frac{\phi l_a}{3.19A}$	$= \frac{\phi l_a}{0.4\pi A}$
l (LENGTH—l_s = STEEL—l_a = AIR	= INCHES = CM X .3937 = 2.54 CM	= CM = INCHES X 2.54 = 39 INCHES
A (AREA)	= SQ. IN = SQ. CM. X .155 = 6.45 SQ. CM.	= SQ. CM. = SQ. IN. X 6.45 = .155 SQ. IN
B (NORMAL INDUCTION IN ANY MATERIAL)	$= 3.19\mu H = \frac{\phi}{A} = \frac{M.M.F.}{\frac{l_a}{3.19} + \frac{l_s}{3.19\mu}}$ = MAXWELLS/SQ. IN = GAUSSES X 6.45	$= \mu H = \frac{\phi}{A} = \frac{MMF}{l_a + \frac{l_s}{\mu}}$ = GAUSSES = MAXW./SQ. CM. = MAXW./SQ. IN X 0.155
B (MAGNETIC INDUCTION IN AIR)	$= 3.19H = \frac{\phi}{A}$ = MAXWELLS PER SQ. IN	$= H = \frac{\phi}{A}$ = GAUSSES
H (MAGNETIZING FORCE)	$= \frac{NI}{l} = \frac{B}{3.19\mu}$ = NI PER INCH LENGTH = OERSTEDS X 2.02	$= \frac{0.4\pi NI}{l} = \frac{B}{\mu}$ = OERSTEDS = GILBERTS/CM LENGTH = NI PER IN. LGTH X 0.495
µ (PERMEABILITY FOR ANY MAT'L)	$= \frac{B}{3.19H}$	$= \frac{B}{H}$
µ (FOR AIR)	= 1	= 1
µa (APPARENT AC PERMEABILITY)	$= \frac{10^8 l L_a}{3.19N^2AK_1}$	$= \frac{10^8 l L_a}{0.4\pi N^2AK_1}$
La (APPARENT INDUCT. IN HENRIES	$\frac{3.19N^2\mu_a AK_1}{10^8 l} = \frac{N^2}{10^8\left(\frac{l_s}{3.19\mu_a A_s} + \frac{l_a}{3.19A_a}\right)}$	$= \frac{0.4\pi N^2\mu_a AK_1}{10^8 l} = \frac{0.4\pi N^2}{10^8\left(\frac{l_s}{\mu_a A} + \frac{l_a}{A_a}\right)}$

MISC. FORMULAE

$$L_a = \sqrt{\frac{Z^2 - R_a^2}{4\pi^2 f^2}} = \frac{0.159\sqrt{Z^2 - R_a^2}}{f} = \frac{X_L}{2\pi f} \text{ OR, IF } R_a \text{ IS SMALL} = \frac{0.159Z}{f}$$

$$B_{ac} = \frac{10^8 E_{rms}}{4.44fANK_1} \quad E_{rms} = \frac{4.44N\phi_{max}}{10^8} \quad \phi_{max} = \frac{10^8 E_{rms}}{4.44fN} \quad N = \frac{10^8 E_{rms}}{4.44f\phi_{max}} = \frac{10^8 E_{rms}}{4.44fAB_{ac}K_1}$$

$Z = \sqrt{X_L^2 + R_a^2}$ $X_L = 2\pi f L_a$ Z = IMPEDANCE IN OHMS f = CYCLES/SEC. π = 3.1416 Ra = APPARENT RESTANCE IN OHMS X_L = INDUCTIVE REACTANCE IN OHMS K_1 = STACKING FACTOR

Symbols and equivalent English and C.G.S. units of common magnetic terms and formulas.

By JOHN W. STRAEDE

BEAT-FREQUENCY OSCILLATOR

An Excellent Instrument for the Advanced Serviceman

THE type of audio-frequency oscillator described in this article consists essentially of two high-frequency oscillators, the alternating voltage outputs of which are mixed, i.e., added together and rectified, the resultant being an alternating voltage the frequency of which is the difference between the frequencies of the high-frequency oscillators.

Audio-frequency oscillators have many uses, such as measurement of frequency response of an amplifier or a.f. section of a receiver, signal for locating rattles, squeaks and buzzes in radio cabinets and auditoriums (including ordinary rooms), alternating voltage source for measuring impedance of a loudspeaker, microphone, pick-up or cutting head. They also form part of the equipment for measurement of loudspeaker and microphone response. An accurately calibrated variable-frequency oscillator can be used as a source for measurement of inductances and capacities by resonance methods. (In later articles it is hoped to describe auxiliary equipment and procedures for some of the above).

This particular beat-frequency oscillator has a number of constructional and circuit features making it very useful for the experimenter, radio serviceman, teacher and amplifier enthusiast.

CONSTRUCTIONAL FEATURES

The beat-frequency oscillator is compact and easily carried around.

The entire job is very compact, the case measuring only 10 x 7 x 7 inches. The small size is due mainly to the employment of only four tubes (one each 6K7-GT, 6J8-GT, 6V6-GT and 6X5-GT). Bantam type tubes are employed but there is enough room for full size "G" types—a 5Y3-G rectifier was used in one version. Controls are only 3 in number: Zero set, Tune (frequency control) and Volume.

Ordinary radio parts are used throughout except that a slight modification is required of the one-gang condenser if the instrument is to be most useful.

With the exception of the 2000-ohm filter, all resistors are of the carbon type. Ordinary shielded coils in cans 1½ x 1½ x 3 inches high, are the only ones used. No modification is necessary except that a few small condensers and resistors are squeezed inside the cans to facilitate shielding.

Probably the weakest part is the output transformer, although here again the sacrifice of some volume enabled fair results to be obtained.

CIRCUIT DETAILS

The 6K7-GT (which can be replaced by 6U7-G or 6D6) is employed as a fixed frequency oscillator using an electron-coupled output circuit so that signals applied to the plate from an external source will have little or no effect on the oscillator frequency. *It is highly desirable in the design of beat-frequency oscillators that there be as little coupling (or energy transfer) as possible between the tuned circuits,* otherwise waveform distortion and *locking-in* occur when low output frequencies are required. Locking-in means that the two high-frequency oscillators jump into synchronism so that no output beat signal is produced.

The variable-frequency oscillator consists of the triode portion of the 6J8-G—here the circuit is very similar to that of a conventional superhet—electron coupling being provided in the hexode portion of the tube.

Production of reasonably good wave form requires that at least one oscillator output be free from harmonics and that no overload occurs in the output stage.

By having the fixed frequency oscillator barely oscillating, that is, working at low signal level, its wave form is fairly pure, a plate-to-ground condenser discriminating against any harmonics that might be produced.

Inverse or negative feedback is employed over the output stage to reduce any distortion produced by the 6V6. Theoretically the amount of feedback varies with the setting of the volume control in the circuit shown, an effect which would cause a slight change in frequency response between low and full volume. However the change is a very minor one indeed, as the output is provided with an almost constant resistive load consisting of a 10,000-ohm resistor and a 0.1 microfarad fixed condenser.

To prevent too great attenuation of the lower frequencies the cathode bypass condenser was made unusually large—100 μf being used.

Space was saved by omitting the usual power choke and employing a

(*Continued on page 66*)

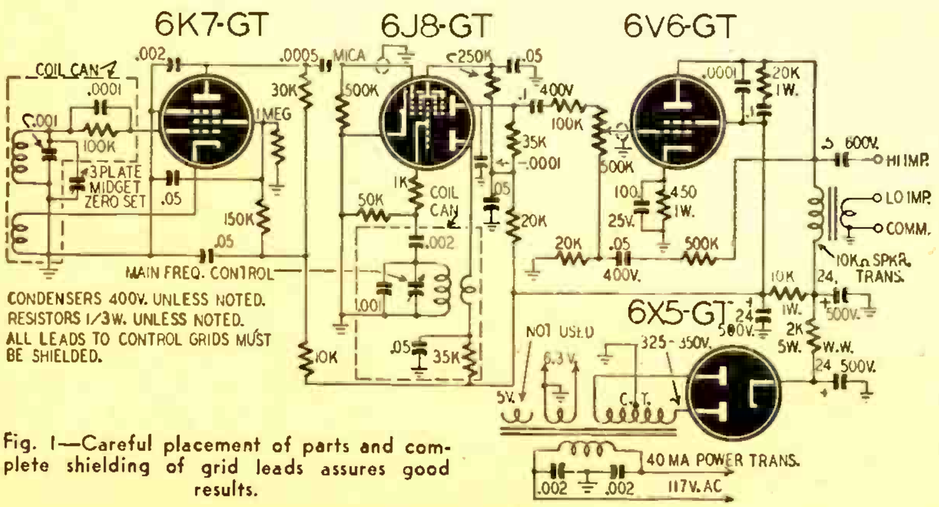
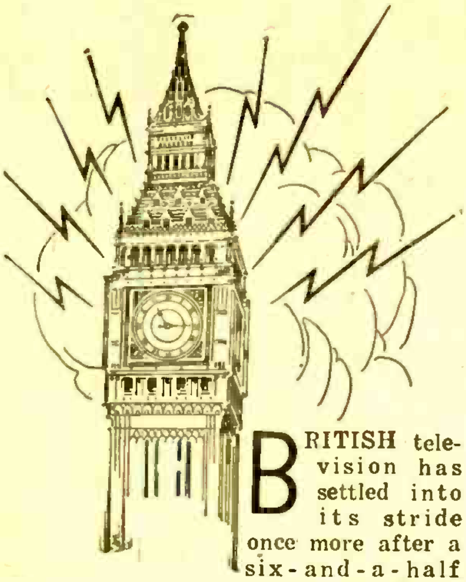


Fig. 1—Careful placement of parts and complete shielding of grid leads assures good results.



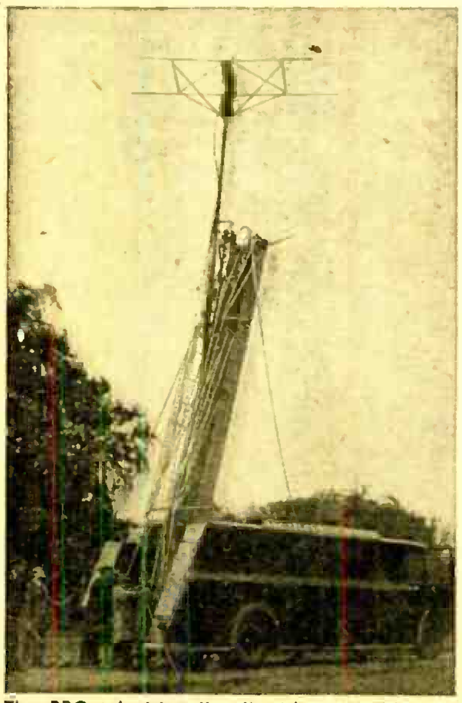
TRANSATLANTIC NEWS

From our European Correspondent, Major Ralph Hallows

BRITISH television has settled into its stride once more after a six-and-a-half years' sign-off during the war and the period immediately following its end. Though many of the programmes come from the studio, outside broadcasts—or O.B.'s—are frequent. Almost every interesting event, sporting or otherwise, which takes place in or near London is broadcast for the benefit of televiewers. Arrangements which make such broadcasts possible may be of interest to American readers.

The heart of London is "piped" with a special coaxial cable devoted entirely to television. Starting at the Alexandra Palace, where the television station stands on high ground to the north of the city, the cable is so routed that it serves good vantage points for most of the important events in the life of the capital. Numbers of tapping-in places are provided on the cable and others can be arranged quickly if required.

The British Broadcasting Corporation has two complete mobile television outfits, each of which consists of three large trucks of much the same shape and size as single-decker buses. One of these contains a complete control-room, with sound and vision monitoring arrangements and fade-in controls for two *emitrons*. The emitron is the British version of the super-iconoscope television camera. Each emitron has 1000 feet of flexible cable and can be used that distance from the control van.



The BBC television "van" with extensible antenna which increases the range to 20 miles.

Normally power is obtained from the lighting mains by tapping in. This is not always feasible, for parts of London still have d.c. and in other parts a.c. supplies are not of standard voltage and frequency. Where the mains supplies are unsuitable, the second van, containing generating equipment, is brought into use.

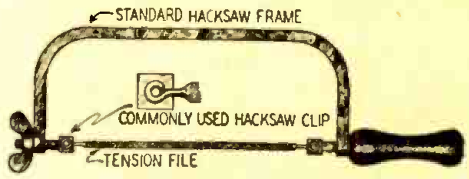
The third van, seen in the accompanying photograph, contains a complete medium-powered sound and vision transmitter. It has an antenna which can be raised to 80 feet by means of ladders extending on the "fire-escape" system. The transmitter truck is used when the scene of a television O.B. is too distant to allow tapping in on the coaxial cable. It extends the range of O.B.'s to 15-20 miles from the Alexandra Palace station. Sometimes transmissions are received direct at the Alexandra Palace by means of a small antenna fixed above the main broadcasting array; but this is often found to be impracticable for various reasons. In such cases the transmissions from the truck are received at a substation situated on the heights of Highgate and relayed to the Alexandra Palace by means of the coaxial cable mentioned, which runs close to the substation.

The results are extremely satisfactory. An extension of the London coaxial cable is planned. Soon a second television broadcasting station will be at work in the Birmingham area and that will be followed by other main stations in different parts of the country. All will be inter-linked by cable or by radio and the larger ones will have their own O.B. outfits. It will thus be possible before long to make vision broadcasts from London of events occurring all over Britain. Smaller relay stations will also take their programmes from one or other of the big fellows.

The modulation system, by the way, is the reverse of that used in the United States. With us 30 percent carrier gives black and 100 percent white. The sync pulses are "blacker than black" taking the carrier down to zero. There are many who think that we should have ensured better definition had we adopted the American method. It is certainly a pity that we decided on vertical polarization when the London station was erected in 1935. The superiority of horizontal polarization in the matter of auto ignition interference was not then realized and I suppose that vertical was chosen because it makes the transmitting antenna problem so much more simple. It certainly would be no easy matter to devise and erect a horizontal array giving fairly uniform field strength in a service area of circular shape.

A RUSSIAN GIANT

The Russians have just announced that a new high-powered station, Soviet Latvia, is nearly completed and will start transmitting very soon on 582.9 kc. The power rating of the station is not given, but it is stated that it will be powerful enough to cover most of Europe. I hear on good authority that the power output will be 500 kw, with more in reserve when required. Soviet Latvia should be heard in America at night this winter. It will probably continue working until 2 a.m. G.M.T., or 9 p.m. E.S.T. on most nights of the week. Strictly speaking, Russia is within her rights in operating the station on that frequency for it was allotted by the Lucerne Plan to Latvia and Tunis. It was, though, laid down that both of these stations should be of low power and should provide purely local services. The Russian announcement follows hard on the heels of one by the B.B.C. that it would start its new highbrow program on September 29th on 582.9 kc. As Soviet Latvia would certainly interfere after dark, another channel will have to be found—and that's no easy matter in Europe nowadays!



The tension file is a scroll-saw for metal.

STANDARDIZED SCREWS

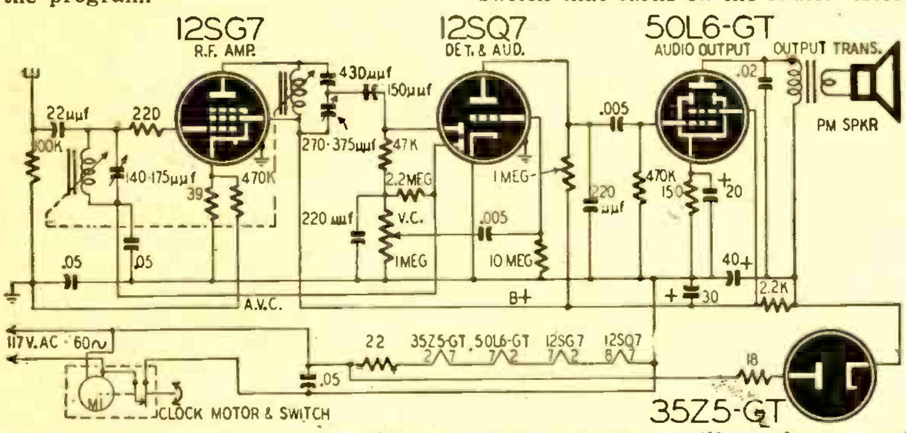
It's good to hear that there is a movement on foot for the adoption of a common standard of screw threads by Britain and the United States. I forget how many million dollars the difference in standards cost during the war, but I recall that the figures were astronomical. But I can speak with feeling of the bad language and the waste of time that result from losing a nut off an American radio or electrical part and being unable to find any British nut that will take its place. I'd be glad if we could do some further common standardizing with wire gauges and I'm sure that that goes too for most radio fans in both countries. If you read one of our constructional articles or we

(Continued on page 67)

THE POSTWAR RADIOS

Telechron Musalarm

THE new Telechron Musalarm combines the best features of a compact radio and a self-starting electric alarm clock. These features make the set equally useful in the kitchen or in the bedroom. When the alarm is set for a particular time and the receiver is tuned to a favorite radio station, the user may be aroused from deep slumber by the crooning voice of the announcer on the Early Bird program. The Little Woman may want to set the alarm for her favorite soap opera. In this way, she can go about her housework without having to turn on the radio in time for the program.



This radio is enclosed in an attractive brown bakelite cabinet, 10¾ inches wide by 4¾ inches deep by 5¾ inches high. A 3½-inch clock, with a Telechron movement, is included in the cabinet. It is equipped with an auxiliary buzzer alarm set to go off in seven to ten minutes after the set has been automatically turned on. This alarm continues to sound until the ALARM SET knob is pressed.

The clock begins to run when the line cord is plugged into a 110 to 120-volt, 60 cycle, a.c. line. If it is desired to have the set turned on in time for a favorite program, the ALARM-OFF-ON switch is turned to the ALARM position and the ALARM SET knob is turned to the program time. The receiver is tuned to the desired station. When the time arrives, the clock movement actuates a switch that turns on the radio. After a short time, the auxiliary alarm sounds, unless the ALARM SET knob is depressed at the time that the adjustment is made.

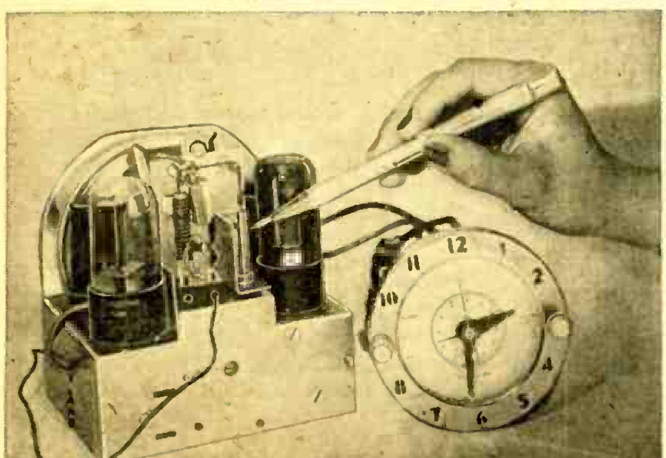
To operate the radio manually, the ALARM-OFF-ON switch is turned to ON. The alarm may be used by merely setting the ALARM SET knob to the desired time. When the time arrives, the alarm will sound with sufficient volume to be heard above the sound of the radio.

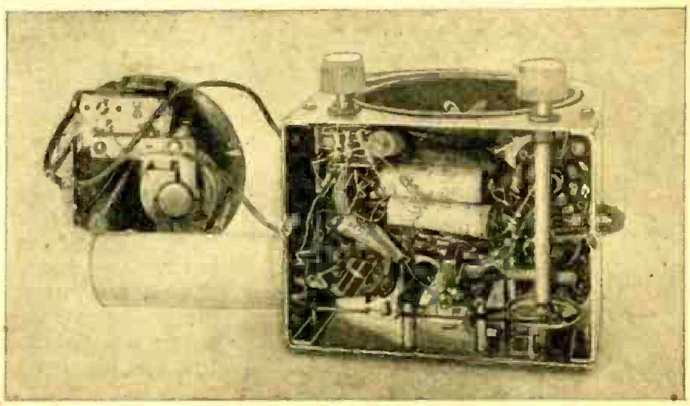
A t.r.f. circuit is used in the receiver. A 12SG7 r.f. amplifier is followed by a 12SQ7 diode detector, a.v.c and first a.f. stage. A 50L6-GT power amplifier and a 35Z5-GT rectifier complete the tube line-up.

Permeability tuning is used in the grid and plate circuits of the 12SG7. The set is tuned by sliding the ganged powdered iron cores in or out of the coils. The tuning mechanism is shown in the photos. The grid circuit uses a 140 to 170-μμf trimmer condenser connected across the coil. The plate coil uses a 270 to 275-μμf trimmer connected in series with a 430-μμf fixed condenser. The lead to the detector diode plate is connected at the junction of these two condensers. This type of coupling minimizes the loading effect of the diode, thus improving the selectivity of the circuit. The detector diode load consists of a 47,000-ohm resistor connected in series with a 1-megohm volume control. The a.v.c. diode is connected through a 2.2-megohm resistor to the junction of the volume control and the 47,000-ohm resistor. A.v.c. voltage is applied to the grid circuit of the r.f. amplifier.

The triode section of the 12SQ7 is a contact-biased first a.f. amplifier resistance-capacity coupled to the 50L6-

(Continued on page 55)





Left—Back-chassis view of radio and face view of clock. Bucket-in-the-well permeability tuning device is well shown in this and in under-chassis view above where the tuning shaft and pulley can be seen.

SOUND ENGINEERING — No. 25

This department is conducted for the benefit of RADIO-CRAFT subscribers. All design, engineering, or theoretical questions of general interest on PA installation, sound equipment, and audio amplifier design will be answered in this section. No circuit diagrams can be supplied by mail, all answers being printed in order of their receipt.

(Note: when questions refer to circuit diagrams published in past issues of technical literature, the original, or a copy of the circuit should be supplied in order to facilitate reply.)

PRE-AMPLIFIER

The Question . . . .

I am enclosing stamped self-addressed envelope and circuit diagram (Fig. 1) of a pre-amplifier I wish to build. It is actually an old single stage unit, rebuilt, with separate power supply. I wish to use the old power supply with the new unit.

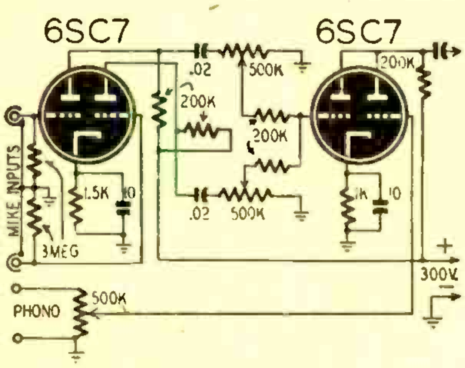


Fig. 1—Original circuit of a pre-amplifier.

The new unit is to feed into the phono jack of my present amplifier which uses a 1612 in the first stage. Will you kindly have your Sound Department check part values on enclosed diagram and finish output circuit, to feed former phono input?

RALPH LEBRUN
Geneva, New York

The Answer . . . .

I am sorry that questions to this department cannot be answered by mail. They can only be answered through publication in this section. A corrected circuit diagram of the type of pre-amplifier you are interested in is indicated in Fig 2. You will note that six major changes have been incorporated, which will insure satisfactory operation. The cathode resistor and by-pass condenser in the first stage have been eliminated to avoid excessive hum and noise pick-up. The mixer circuit has been altered to keep inter-action between controls at a minimum. In the circuit indicated, approximately 2-db change will be noted in the level of one microphone circuit when the remaining "mike" control is varied from minimum to maximum. Your original circuit produced a change of approximately 6 db. The bias of the second 6SC7 has been increased to enable this stage to handle 1 volt input adequately without introducing excessive distortion. A decoupling resistor has been inserted between the two stages to avoid possibility of motor-boating. The plate load of the first stage has been increased from 200.000 ohms to 500,000 ohms to provide increased gain and to limit plate current as the stage is operating under a "no bias" condition. The coupling condensers between stages have been increased from .02 to .05 µf to provide a better low frequency response.

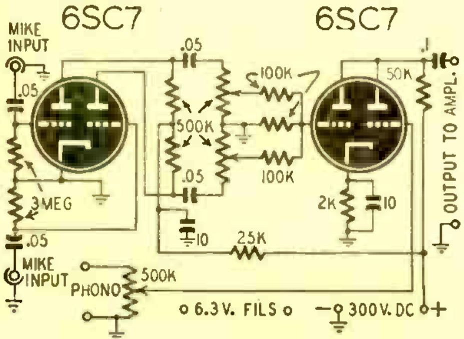


Fig. 2—Circuit of Fig. 1 with improvements.

MIDGET AMPLIFIER

The Question . . . .

I intend to build the Midget Amplifier as shown on the enclosed diagram (Fig. 3). But, I am not sure about the voltage ratings of the condensers and wattage ratings of the resistors. Also, the two 20 µf units, 10 µf unit, and the 40 µf unit. Must they be electrolytic condensers? I am under the impression that the two 20 µf units are bypass condensers.

Please send me a complete parts list giving the wattage of resistors and voltage rating of condensers. Also, I would like to know if this amplifier would handle an 8-inch PM speaker as well as a 3- or 4-inch. Inform me whether the high frequency cut is an ordinary 0.5 megohm tone control, or whether it is a special control.

Thanking you kindly.

DEAN HORN
Columbus, Indiana

The Answer . . . .

The voltage rating of the condensers and the wattage rating of the resistors follow:

Condensers	*Resistors*
40 µf—200 v	500,000 ohms—½ watt
20 — 25 v	250,000 —½ watt
20 — 25 v	25,000 — 1 watt
10 —150 v	3,000 — 2 watt
0.1 —200 v	1,000 — 1 watt
0.1 —200 v	200 — 2 watt
.003—200 v	50 —½ watt

The power output of the amplifier will be approximately 2 watts. This should be adequate to operate an 8-inch speaker. However, a 3- or 4-inch speaker, if operated at low levels, will probably provide better frequency response. The high-frequency control may employ an ordinary ½-meg potentiometer. One with an audio grid taper will probably provide smoother high-frequency cut-off action.

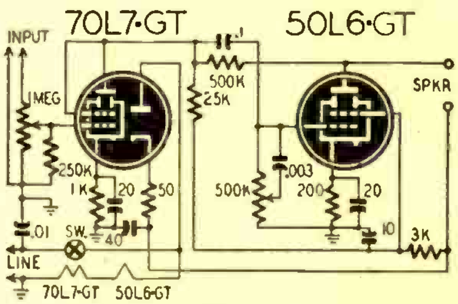


Fig 3—The 2-tube Midget Amplifier circuit.

TRANSFORMER DATA

The Question . . . .

Will you kindly tell me what should be the a.c. RMS voltage of the two plate transformer windings for the Direct-Coupled Recording Playback Amplifier described in the November 1940 issue of RADIO-CRAFT? Also, I would like to know the current rating for the winding supplying the plates of the 5U4-G rectifier tube.

WARREN E. HAIGHT
Wilmington, Delaware

The Answer . . . .

The loaded a.c. RMS voltages of the transformer windings together with their indicated current carrying capacities are listed below:

1. High Voltage Secondary—380 volts each side of center tap at 250 mils.
2. Bias Secondary—187 volts each side of center tap at 250 mils. The voltage and current ratings of the remaining windings also follow:

5U4G filament—5 volts at 3 amp.
5V4G filament—rated at 5 volts at 2 amp.

(Continued on page 63)

Edited by ELMER R. FULLER

WORLD-WIDE STATION LIST

AT PRESENT the Australians and Russians seem to be the best dx catches one can find on the shortwave bands; both being very well received. The Aussies are best on VLG on 9.580 megacycles and VLC6 on 9.615 megacycles. The time is 9 to 10 am; 10:15 to 10:45 am; 11 am to noon for the Australians, and 5:15 to 5:30 am; 8:30 to 9:50 am; 11 am to noon for the Russians. Moscow is heard on several frequencies, but 11.88 megacycles seems to be best for reception on the east coast. Times of transmission are 6:45 to 8 am and 6:30 to 7:30 pm.

ZOY is a government-owned station on the Gold Coast of Africa, which operates with a power of 1.5 kw in the 41-meter band, and with 5 kw in the 61-meter band. Their schedule is daily except Sunday, at 10:55 am to 1:40 pm, EST. Most of the programs are in English and include Gold Coast news, talks, and music in English. The 41-meter or 7.295-megacycle frequency is badly QRM'ed by the 40-meter amateur cw band; but the other frequency is fairly well received here on the east coast. Verification reports are welcomed and a letter of VERI is sent out to listeners who furnish accurate reports on reception of ZOY. It takes about two months to obtain a reply to your report, so be patient while waiting for a reply and do not think they have forgotten it. The address is P.O. Box 250, Accra, Gold Coast Colony.

HER7 in Switzerland has been heard testing on 17.784 megacycles with a new transmitter. We have received one report on their transmission from 10:05 am to noon. Further reports on this transmitter would be greatly appreciated by your editor. Other Swiss transmitters are heard on 7.380 megacycles from 3:10 to 3:30 pm and 6:30 to 8 pm and on 9.185 megacycles from 7:15 to 8 am. These are both beamed to North American listeners and are well received on this side of the big pond.

Radio-Dakar is very well received here on 11.714 megacycles about 3:30 pm, week days. Complete information on this station was given in the last issue of RADIO-CRAFT, including frequencies and schedules. It is well worth trying for. Radio-France and the BBC are both showing their usual pep at this time of the year, and may be heard almost any time on several frequencies.

A report has been received on HOXB in Panama, on a frequency of 11.810 megacycles. They would like reception reports, which may be sent to Station HOXB; Box 1335; Panama City, Republic of Panama. Sorry but we do not have the frequency or schedule of this station. Please let us hear what you know about it.

Radio Luxembourg is heard on 6.090 megacycles on Sundays, 2:30 to 6 pm; Monday to Friday, 2:30 to 4:30 pm; and Saturday in English from 2:30 to 4:30 pm and in French from 4:30 to 6 pm. ZFY in Georgetown, British Guiana, is heard relaying the BBC at 5:45 pm on 6.000 mc. KU5Q on Guam, in the Marianas, is heard on 7.645, 9.280, and 9.670 mc most of the day and night. Reception is very good on the west coast and is fairly good on the East Coast.

Signals from Vienna, Austria, are heard from about 11 pm until about 7 pm the following day. The frequencies are 7.315 and 6.250 (best reception) and 12.00 megacycles. SUV in Cairo, Egypt, is heard irregularly, relaying programs to the armed forces about 7 pm; and later in the evening as point-to-point communication. The frequency in use at present is 10.060 megacycles.

All schedules are Eastern Standard Time

Freq.	Station	Location and Schedule
2.500	WWV	WASHINGTON, D. C.: U.S. Bureau of Standards; 6 pm to 8 am.
2.880	GRC	LONDON, ENGLAND;
3.228	HDZ	RIOBAWBA, ECUAOOR: Thursdays, 9 pm.
3.310	YV1RO	TRUJILLO, VENEZUELA: 5 to 9:30 pm.
3.340	VUD3	DELHI, INDIA: 11 to 11:45 am.
3.370	YV1RT	MARACAIBO, VENEZUELA: 5:30 to 10:30 pm.
3.380	YV5RY	CARACAS, VENEZUELA: 9:30 am to 10:30 pm.
3.390	YV4RK	MARACAY, VENEZUELA; 6 to 10:30 pm.
3.400	YV5RW	CARACAS, VENEZUELA: 5:30 am to 10:30 pm.
3.420	YV2RC	MARIDA, VENEZUELA: 6 to 9:30 pm.
3.440	YV1RU	MARACAIBO, VENEZUELA: 7 to 9:30 pm.
3.460	YV4RP	VALENCIA, VENEZUELA; 8 to 9:30 pm.
3.480	YV4RQ	PUERTO CABALLO, VENEZUELA: 5 to 9:30 pm.
3.490	YV3RS	BARQUISIMETD, VENEZUELA; 4:30 to 9:30 pm.
3.500	YV5RX	CARACAS, VENEZUELA: 6:30 am to 10:30 pm.
3.500	COCX	HAVANA, CUBA; heard evenings.
3.510	YV6RC	BARQUISIMETO, VENEZUELA: 6 to 9:30 pm.
3.530	YV5RS	CARACAS, VENEZUELA; 5:30 am to 10:30 pm.
3.914	ZQP	LUSAKA, RHODESIA; 10:30 am to 1 pm.
3.935	HC5EH	CIUDAO CUENCA, ECUADOR: 6 to 10:30 pm.
4.040		PONTA DEL GADA, AZORES: 4 to 6 pm.
4.105	HCJB	QUITO, ECUADOR: 6 to 10:30 pm.
4.600	HHCA	PORT-AU-PRINCE, HAITI; 7:30 to 9 am; 5 to 9:30 pm.
4.750	YV1RV	MARACAIBO, VENEZUELA: 6 to 9:30 pm.
4.760	YV5RV	LA GUAIRA, VENEZUELA: 5 to 9:30 pm.
4.770	YV1RY	CORO, VENEZUELA: 4 to 10 pm.
4.780	YV4RO	VALENCIA, VENEZUELA: 4:30 to 9:30 pm.
4.765	HJAB	BARRANQUILLA, COLOMBIA: 5 to 10:55 pm.
4.810	YV1RL	MARACAIBO, VENEZUELA; 6:30 am to 11 pm.
4.815	HJBB	CUCUTA, COLOMBIA: 5 to 10 pm.
4.825	HJEO	CALI, COLOMBIA; 7 to 11 pm.
4.640	YV1RZ	VOLERA, VENEZUELA; 4:30 to 9:45 pm.
4.855	HJCA	BOGOTA, COLOMBIA: 6 to 10 pm.
4.865		BELEM, BRAZIL; 5 to 7 pm; 8 to 9 pm.
4.880	HJFH	ARMENIA, COLOMBIA: 6 am to 10 pm.
4.890	YV5RM	CARACAS, VENEZUELA: 5:30 to 10:30 pm.
4.895	HJCH	BOGOTA, COLOMBIA: 6 to 10 pm.
4.920	CR7BO	LOURENCO MARQUES, MOZAMBIQUE: Sundays, 11 am to noon.
4.920	YV5RN	CARACAS, VENEZUELA: 6 am to 10:30 pm.
4.925	HJAP	CARTAGENA, COLOMBIA: 6 am to 1 pm; 5 to 10 pm.
4.945	HJCW	BOGOTA, COLOMBIA; 6:45 am to 11:15 pm; 4 to 6 pm; 7 pm to 11:15 am.
4.950	VQ7LD	NAIROBI, KENYA; noon to 2 pm.
4.955	HJCQ	BOGOTA, COLOMBIA: 10 am to 2 pm; 5 to 11 pm.
4.965	HJAE	CARTAGENA, COLOMBIA; 4 to 10:30 pm.
4.965		ADDIS ABABA, ETHIOPIA: 11:30 am to 12:30 pm.
4.975	HJAG	BARRANQUILLA, COLOMBIA: 9 am to 11 pm.
4.990	YV3RN	BARQUISIMETO, VENEZUELA; 6:30 am to 10:30 pm.
5.000	WWV	WASHINGTON, D.C.: U.S. Bureau of Standards; frequency, time and musical pitch; broadcasts continuously day and night.
5.400		BANDOENG, NETHERLANDS INDIES; early mornings.
5.440		MOSCOW, U.S.S.R.; 8 am to 6 pm.
5.560	OAX1B	PUIRA, PERU, 6 pm to midnight.
5.750	PZX3	PARAMARBO, SURINAN; 6 to 8:45 pm.
5.815		MOSCOW, U.S.S.R.; 11 am to 6 pm.
5.875	HRN	TAGUCIGALPA, HONDURAS: 8 to 10 am; 6 to 11 pm.
5.885	ZRK	CAPETOWN, SOUTH AFRICA: 11:45 pm to 1:30 am; 10 am to 4 pm.
5.890		MOSCOW, U.S.S.R.; 8 pm to 6 am; 8 am to 4:45 pm.
5.895	OAX4Z	LIMA, PERU; 4:30 to 11:30 pm.
5.910	XGOA	CHUNGKING, CHINA; 4 am to ?
5.940	OAX4V	LIMA, PERU; 6 pm to midnight.
5.947	HH2S	PORT-AU-PRINCE, HAITI; 11 am to 1 pm; 5:30 to 9:30 pm.
5.960		MOSCOW, U.S.S.R.; 11 am to 6 pm.
5.960	FG8AA	POINTE-A-PITRE, GUADELOUPE: 11:30 am to 12:45 pm; 6 to 7:30 pm.
5.968	HVJ	VATICAN CITY; 11 am to noon; 1 to 3 pm.
5.970	VONH	ST. JOHNS, NEWFOUNDLAND; 10 am to 2 pm; 3 to 10 pm.
5.985	LRSI	BUENOS AIRES, ARGENTINA: 7 to 10 pm.
6.000	ZFY	GEORGETOWN, BRITISH GUIANA; 5:45 to 7:45 am; 9:45 to 11:45 am; 2:15 to 7:15 pm.

(Continued on page 60)

RADIO TERM ILLUSTRATED

"A Good Conductor"

RADIO DATA SHEET 341

GAROD MODEL 6AU-1

LINE VOLTAGE: 105-125 volts, 50-60 cycles, a.c.-d.c.

POWER CONSUMPTION: 30 watts.

TUNING RANGE: Broadcast: 540 to 1650 Kilocycles (180 to 555 meters).

TUBES: The tubes used, and their functions, are as follows:

6SS7 r.f. amplifier
12SA7 converter
6SS7 i.f. amplifier
12SQ7 detector, a.v.c. and audio amp.
50L6GT beam power amplifier
35Z5GT rectifier

ALIGNMENT PROCEDURE:

Should it become necessary at any time to check the alignment of this receiver, proceed as follows:

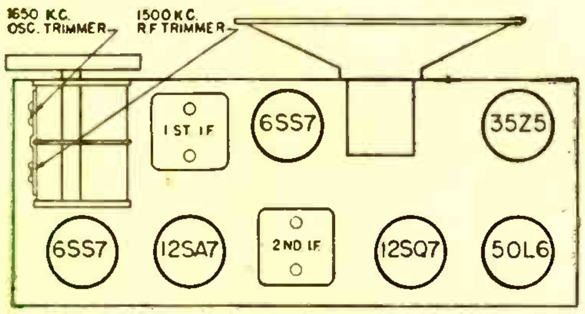
(1) Set the Signal Generator to 455 kc and connect to the grid of the 6SS7 r.f. amplifier, or to the stator lug on the rear section of the variable capacitor. Connect the signal generator ground lead to a –B point underneath the chassis. Connect a suitable output meter across the speaker voice coil connections. First turn the volume control to the maximum position. Turn the variable capacitor to the extreme clockwise position.

(2) Adjust the trimmers located at the top of the first and second i.f. transformers for maximum output as indicated on the output meter.

(3) Loosely couple the signal generator lead to the loop and set to 1650 kc.

(4) With the variable capacitor set at the extreme clockwise position, tune in the 1650 kc signal by means of the oscillator trimmer on the variable capacitor (front section).

(5) Set the signal generator to 1500 kc and turn the tuning control so that this frequency is indicated on the dial. Adjust the antenna trimmer on the variable capacitor (rear section) for maximum output. No other adjustments are necessary.



INSTALLATION:

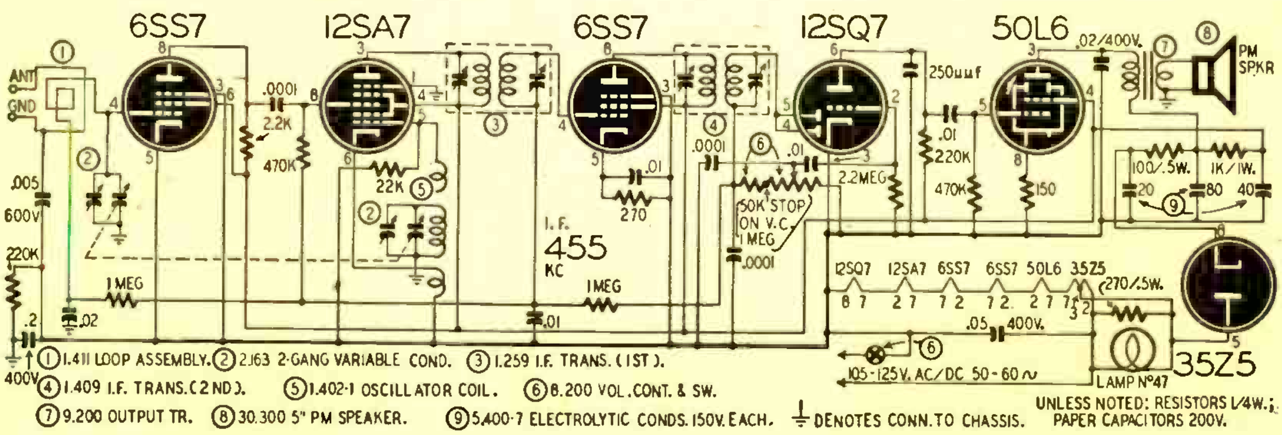
The Model 6AU-1 is complete in every detail for efficient and immediate operation. A self-contained loop antenna is included, which will give excellent results in most locations. Due to the directional properties of the loop, it may be advantageous to turn the receiver to the left or right in noisy locations for maximum signal and minimum noise. A best position for reception can always be found. In unfavorable locations where distant reception is required, a well-constructed outside antenna may be used, and connected to the green wire labeled "Ant." at the rear of the loop.

CONTROLS:

The left-hand knob is the volume control and On-Off switch. The right-hand knob is the station selector tuning control, which selects the desired station along the slide-rule dial, the frequency of which is indicated by the pointer.

CAUTION:

If this receiver is operated on d.c. (Direct Current), it may be necessary to reverse the line cord plug to obtain the correct polarity. Objectionable hum or noise may also be eliminated on a.c. operation by reversing the line cord plug.



RADIO-ELECTRONIC CIRCUITS

TRANSMITTER MONITOR

Here is a circuit of a transmitter monitor that I have found useful for monitoring c.w. and radiotelephone transmissions.

The heterodyne principle is used. A 6K6-G electron-coupled oscillator is designed to operate at a frequency close to that of the transmitter. Regulated voltage on the plate and screen grid and a high-C tank circuit are used to insure adequate frequency stability. The 40-meter coil is wound on a 1-inch form with 20 turns of No. 22 enamel wire tapped at the sixth turn from the bottom.

The output of the oscillator is coupled to the suppressor grid of a 6SK7. The control grid of the 6SK7 is connected to a short antenna to pick up the signal from the transmitter. The 6SK7 mixes the signals from the oscillator and transmitter and applies the difference frequency to the i.f. amplifier section of a superhet receiver.

The receiver is turned ON with the b.f.o. in operation. The transmitter is keyed and the frequency of the monitor adjusted until a beat note is heard in the receiver. The monitor is now tuned to a frequency that will beat with the transmitter fundamental to produce a heterodyne equal to the receiver's intermediate frequency.

To use the monitor: the standby switch of the receiver should be altered so that the i.f. and a.f. sections of the receiver are in operation at all times. Initial adjustments on the monitor are made with the receiver in its standby position.

Douglas K. Vanderwater,
Belleville, Ontario

(Note: Coils may be wound for other frequencies but the monitor will probably work just as well by beating either the fundamental or harmonic of the oscillator with the fundamental or harmonic of the transmitter. The monitor will work as long as the heterodyne difference frequency of the two signals is equal to the receiver i.f.—*Editor)*

VOLTAGE REGULATOR

Here is a circuit of an electronic voltage regulator that I constructed for laboratory experiments.

A 15,000-ohm resistor stabilizes current through the VR-105 which biases the cathode of the lower half of the 6SN7. Both halves of the 6SN7 are used as d.c. amplifiers which amplify any voltage fluctuations due to load variations. The amplified variations are applied to the grid of the 6L6 in the form of bias changes. The plate resistance of the 6L6 varies with the bias, causing the voltage drop across the tube to rise or fall to keep the output voltage constant for varying loads.

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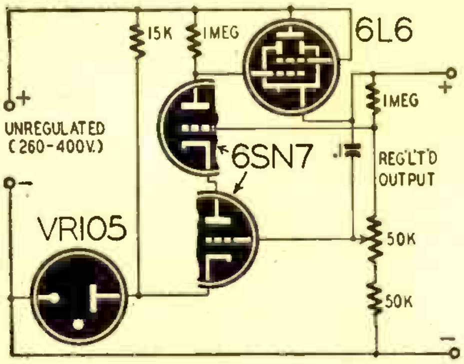


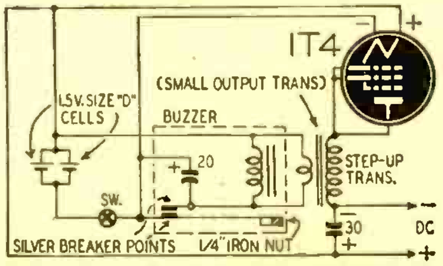
The 0.1 µf condenser is used to increase the effectiveness of control with rapid load changes. The 50,000-ohm potentiometer may be used to give a reasonable range of almost perfectly regulated output voltages.

Pfc. H. W. Merrihew,
Camp Cambell, Ky.

NOVEL POWER SUPPLY

During the recent shortage of miniature B batteries, I designed this unit to power a camera-type portable radio.

The vibrator was made by altering a high-frequency code buzzer. The armature was removed and replaced by an old razor blade that had been ground to shape. The free end of the armature was weighted by a ¼-inch nut soldered to one side. A silver breaker point was fastened to the armature opposite the fixed contact.



A small output transformer was connected with its secondary in the low-voltage circuit. The high-impedance primary is connected in a half-wave rectifier circuit using a 1T4 tube. Two electrolytic condensers filter out the hum and vibrator hash. Two standard flashlight cells, connected in parallel, supply the primary power.

This unit supplies 40 volts with an 8-ma load. The high-voltage leads from the transformer should be reversed to determine best connection.

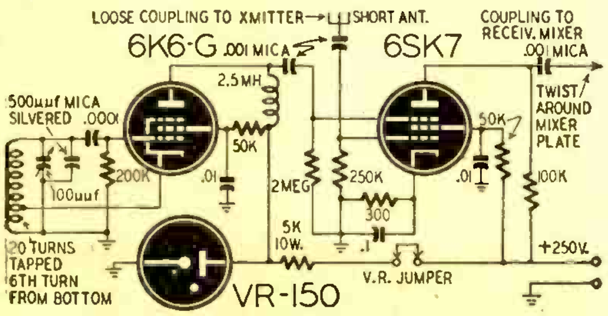
Fred W. Burdon,
St. John, N. B., Canada

115-VOLT D.C. RECEIVER

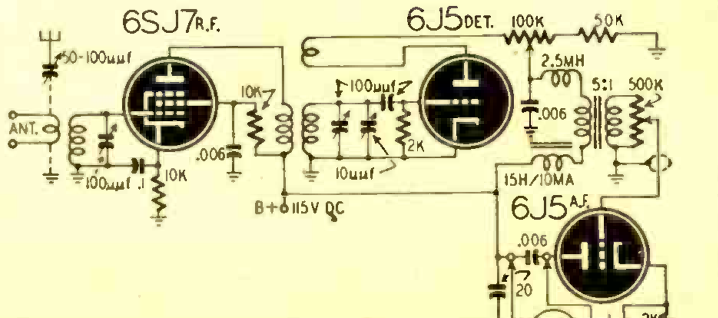
Here is a simple receiver that was constructed aboard ship as an auxiliary h.f. receiver. Standard two- and three-winding coils are used in the r.f. and detector circuits. A 15-henry choke was inserted in the plate lead to the detector to remove all traces of commutator hash.

Filament voltages may be supplied from a six-volt battery or from a line dropping resistor.

James R. Young,
Los Angeles, Calif.



A transmitter monitor to work in conjunction with the station receiver's i.f. amplifier.



A shipboard d.c. receiver. Good line filters are required in most shipboard installations.

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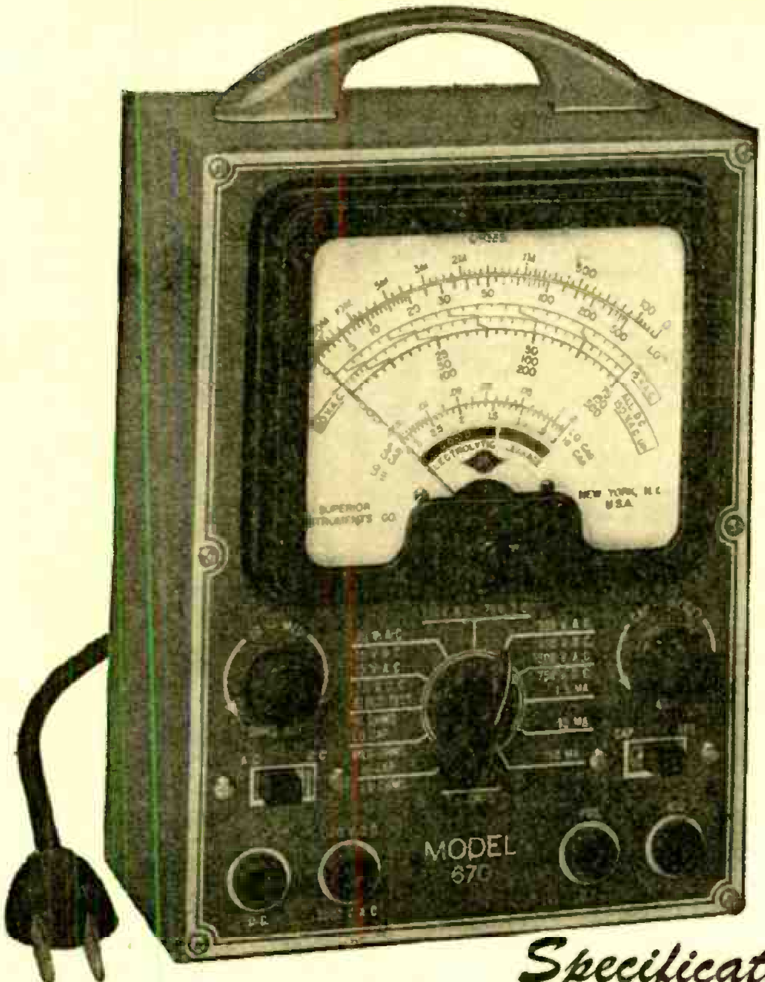

The New Model 670

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Added Feature:

The Model 670 includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

Specifications:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5 Amperes

RESISTANCE: 0 to 500/100,000 ohms 0 to 10 Megohms
CAPACITY: .001 to .2 Mfd. .1 to 4 Mfd. (Quality test for electrolytics)
REACTANCE: 700 to 27,000 Ohms 13,000 Ohms to 3 Megohms
INDUCTANCE: 1.75 to 70 Henries 35 to 8,000 Henries
DECIBELS: —10 to +18 +10 to +38 +30 to +58

The Model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

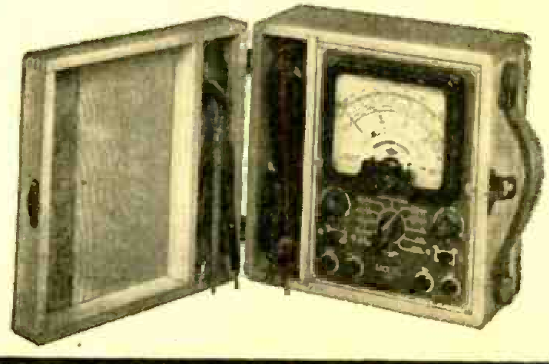
$28.40 NET

Model 670P

The Model 670P is identical to the Model 670 described in detail except housed in a hand-rubbed, portable oak cabinet complete with cover.

The Model 670P comes complete with test leads and all operating instructions.

$35.75 NET



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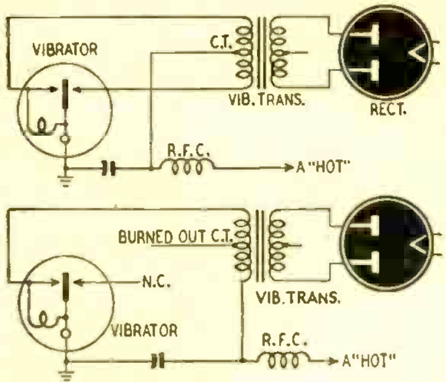
TRY THIS ONE

VIBRATOR KINK

Here is a kink that saved me a lot of time and trouble. My automobile radio developed an open center tap on the primary of the vibrator transformer and I was unable to obtain a replace-



ment. The normal push-pull power input was converted to a single-ended input without noticably affecting the operation of the radio. The diagram is self-explanatory.

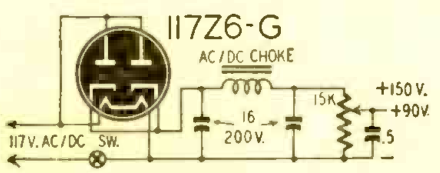
Bob Melvin,
Berkeley, Calif.

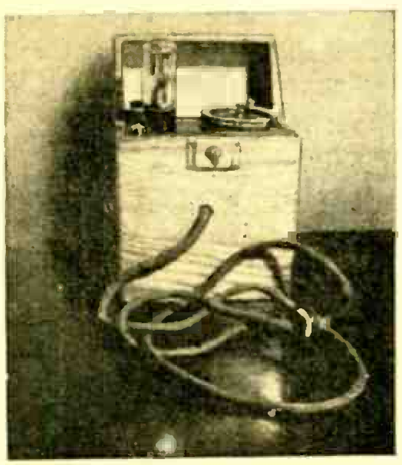
(Note: It may be necessary to add more filter to the output of the rectifier to compensate for the reduced input frequency. Additional chokes and by-pass condensers may be required in stubborn cases to prevent the low-voltage from radiating vibrator "hash."—*Editor)*

BATTERY ELIMINATOR

Here is an a.c.-d.c. battery eliminator for use with battery receivers. The circuit uses a 117Z6-G so that it is not necessary to use a transformer or line dropping resistor. No provisions were made for filament supplies as the added cost of filter condensers and resistors was excessive. A No. 6 dry cell is much cheaper and will last almost indefinitely because the filament drain seldom exceeds 0.5 ampere, and runs usually from 0.2 to 0.25 ampere in most four-tube battery portables.

J. R. Blundin,
Mt. Carmel, Penna.





TUBE SHIELDS

The cap from a burned out fluorescent lamp starter makes an excellent shield for the miniature button-base tubes like the 1R5, 1T4, 6J6 or 6AK5. If the tube has the exhaust tip on the top, it may be necessary to cut a ⅝-inch hole in the top of the cap.

Harry Kundiat,
Garwood, N. J.

Radio-Craft wants original kinks from its readers, and will award a one year subscription for each one published. To be accepted, ideas must be new and useful. Send your pet short-cut or new idea to Radio-Craft today!

SIX-VOLT RECTIFIER

In some instances, the filament of a 35Z5 or 45Z5 will burn out, leaving only the pilot lamp tap in good condition. Instead of discarding such tubes, they should be saved for they may be used in circuits requiring a small rectifier tube with a 6-volt filament. Connect a 6-volt filament winding across the pilot lamp tap of the tube. The cathode is connected to the filter network. This kink is useful in a low-voltage; low-current power supply.

C. Leval,
Englewood, N. J.

USING OLD VIBRATORS

Defective vibrators from battery-powered radios may be used for many purposes around a radio shop.

The bottom of the unit is removed by inserting a screw driver under the rolled edge and bending it outward so that the "works" may be removed. Photo A shows the parts of the vibrator.

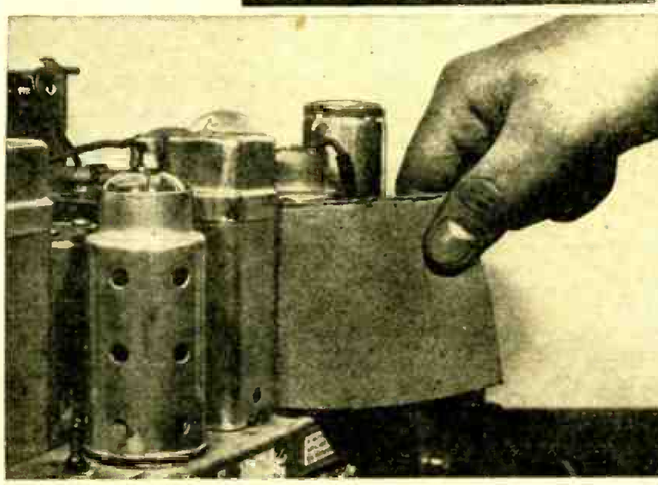
The sponge rubber lining may be inserted between tube shields (as shown in Photo C) to prevent annoying rattles that are caused by vibration. The smaller disc will be useful in replacing worn or misplaced chassis shock absorbers.

The "can" may be used as a container for knobs and other small parts by removing the handle. If angle brackets or spade lugs are attached, the can may be used as a coil shield (Photo B).

H. Leeper,
Canton, Ohio

A

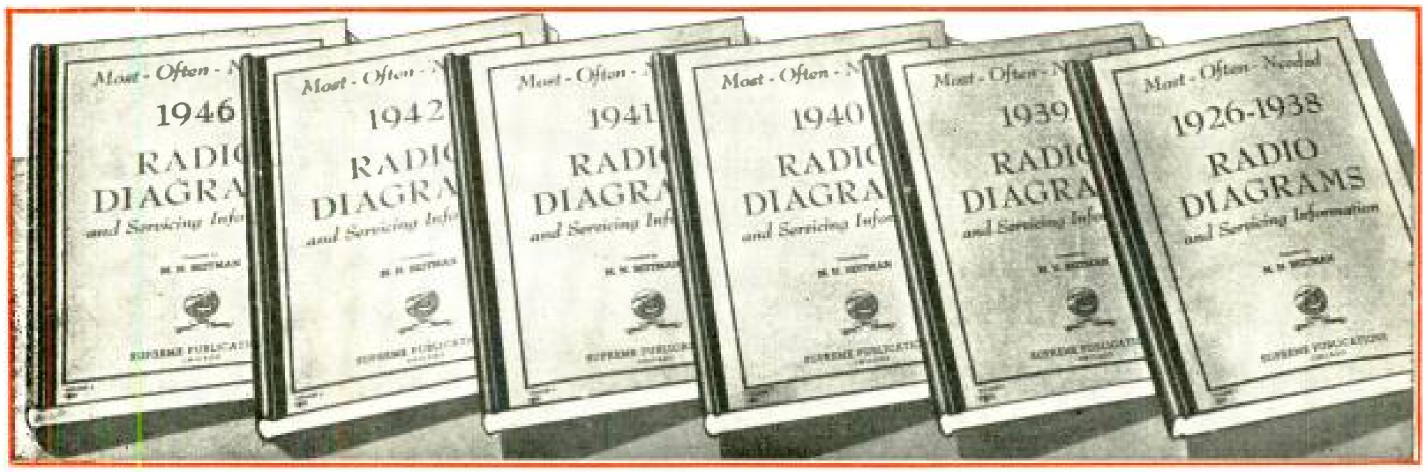
B



C

MOST-OFTEN-NEEDED

RADIO DIAGRAMS



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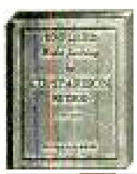

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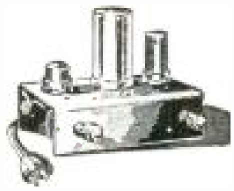

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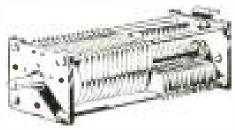

Dual Spaced 110.110 Mfd Variable Condensers . . . . . 95c ea.

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V.M. TWO POST AUTOMATIC RECORD CHANGER

This Record Changer is a well-made mechanism, will play either 10-in. or 12-in. records. The pickup uses a crystal cartridge. Size 14 in. x 14 in. Packed 2 to a factory-sealed carton, factory guaranteed.

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Push Pull 6L6 Shielded Output Transformer 30 Watt Peak, to 2-4-6-8-16-250 and 500 ohm line. $3.45 each. Lots of 12—$3.25 ea.

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10 Watt Large Universal Output—$1.35 ea. Lots of 10—$1.20 ea.

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50 Mill Filter Choke 300 ohm—65c ea. Lots of 10—60c ea.

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100 Mill Filter Choke 250 ohm—$1.10 ea. Lots of 25—$1.00 ea.

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4 in. 450 Ohm Dynamic	$1.75 ea.
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TUBULAR ELECTROLYTIC CONDENSERS

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16 Mfd. 150 Volt—25c ea.
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50 Mfd. 150 Volt—35c ea.
10 Mfd. 450 Volt—39c ea.
20 x 20 Mfd. 150 Volt—43c ea.
30 x 20 Mfd. 150 Volt—47c ea.
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Astatic Low Pressure, Curved Arm, Crystal Pickup with Sapphire Stylus Permanent Needle, has cartridge which replaces LP6-LP21-LP23.
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TECHNOTES

. . . . BALKY HY-75'S

When the HY-75 is used in high frequency circuits, it will sometimes go out of oscillation for no apparent reason. This is usually caused by poor connections between the grid and plate lead wires and their respective caps.

If oscillation failure is due to this source, it can be remedied by holding a hot soldering iron on the caps until the joint is resoldered. Too much heat should not be applied; it may crack the glass or loosen the cap from the tube.

RICHARD L. PARMENTER,
Middleboro, Mass.

. . . . CONDENSER POLARITY

A 10-μf condenser with a 450-volt rating overheated when connected into a receiver's filter circuit. Since the condenser it was replacing had been shorted, suspicion naturally fell on the circuit. The circuit, however, seemed o.k. A new condenser was tried—this unit did not overheat. Furthermore, the B voltage jumped from 200 to 270. The defective condenser was tested, but checked perfect. Close inspection, however, revealed that negative and positive markings had been incorrectly inscribed at the factory. The lead from the external condenser envelope, which is commonly negative, was labeled positive in this case.

S. HELLER,
Bronx, N. Y.

. . . . MANTOLA R-255 CHANGER

If the tone arm on this automatic record-changer swings too far, or not far enough, over, the fault may lie in the copper sleeve's not being held tightly enough by the adjusting screws. To remedy, move the tone arm gently, without forcing, to one end. If it is dropping too far *inside* the record, move it as far as it can go *towards* the record. If it is dropping too far *outside* the record, push arm as far as possible *away* from the record.

If the adjusting screws (located under changer base, on the tone arm assembly) are loose, seize the arm at its base and force it slightly in the direction in which it has already been moved. If the screws are tight, loosen them before adjusting the arm. A slight rotation of the base produces a much greater change of position in the tone arm, so do not move the base very much. When the arm is found to drop in the proper place, tighten the adjusting screws.

Difficulty may be encountered in making adjustments when the record-changer remains in its cabinet, since the base of the pick-up may have shifted when the adjusting screws are tightened. To remedy this condition, the changer should be removed from its cabinet and adjusted on the work-bench.

S. HELLER,
Bronx, N. Y.

MISSILE BACK-TRACKS RADAR BEAM

A beam-climbing missile, not quite perfected by the Germans at the end of the war, was capable of following back to its source a radar beam focussed on a plane or ship. It is possible that it was one of the "wonder-weapons" promised by Hitler to his people, which were to win victory even after Allied forces had crossed the German border. A report issued last month by the U. S. Department of Commerce gives details of the weapon, together with other devices on which the Nazis were just a little too late.

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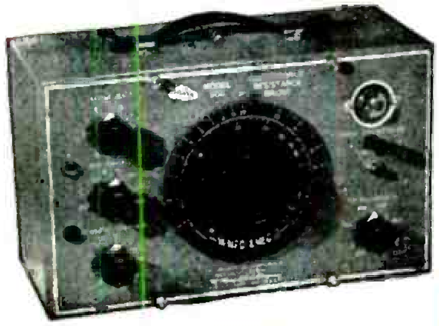

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A GERMAN BRAINWAVE

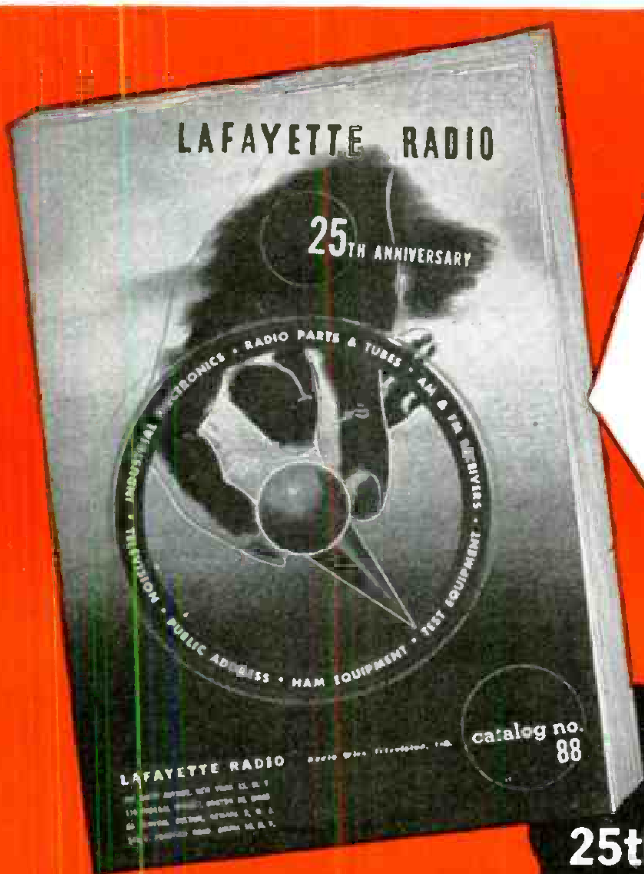
Use of brain waves to manage an artificial leg was the hope of German scientists, an Air Materiel Command Technical Intelligence team learned from questioning the scientists at the Aeronautical Research Institute of Munich.

Brain waves are the records of changes in electric potential that accompany brain activity. Electrical changes always accompany nerve impulse. The electrical currents are a by-product and except from the heart's surface, are extremely weak. Amplifiers are needed to detect and measure them.

The German artificial leg had electro-mechanical devices wired to the cut nerve endings in the patient's stump. The German investigators believed that galvanic electricity flowing along the nerves would supply the power impulses and that these could be controlled mentally, manipulating the leg according to the wishes of the owner. The galvanic electricity is the direct current which is a by-product of nerve impulses.

The amputee would employ varying degrees of concentration on the theory that mental intensity would act like a rheostat, controlling the amount of nervous electricity and moving the leg in the manner desired.

How the Germans expected these weak, microvolt currents to power a leg without an unbearably heavy and bulky amplifier is not stated in the announcement made here today. Neither is there any mention of how the Germans expected to keep the nerve endings in the stump from dying and becoming useless as a source of current.



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THERE is a time in the life of Mr. Serviceman when every repair seems to settle down to a faulty component or broken wire and work loses attraction because it offers no new experience.

Presently a job turns up which withstands all his efforts. Simple as it looks the fault persists. Mr. Serviceman, who believed that radio had no more problems in store for him, puts away test leads and soldering iron and starts with paper and pencil.

For instance, a set has a defective volume control. Not that it does not regulate up to full volume nor is it noisy. It simply does not cut out entirely. In the minimum position, a strong signal still comes through, far too loud to listen to a local at night.

Of course, Mr. Serviceman at once replaces the volume control with a new one. . . . The fault remains, the new volume control does not cut out either. Now he checks both volume controls for resistance from slider to grounded end, in minimum position. It shows zero. As a countercheck he grounds the center terminal directly. The signal still comes through.

If he thinks the signal passes by some obscure way to the grid of the first a.f. amplifier tube—he is right. Let us consult the diagram of the receiver and solve the puzzle.

Figure 1 shows the volume control located in a diode-triode circuit. The modulated r.f. voltages developed across the i.f. transformer secondary cause a flow of electrons from the cathode to the diode plates in the tube on every r.f.

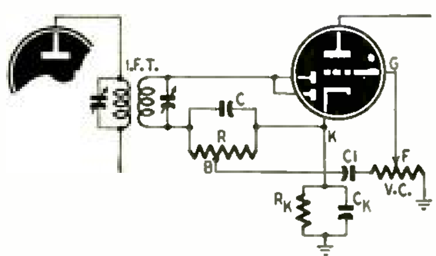


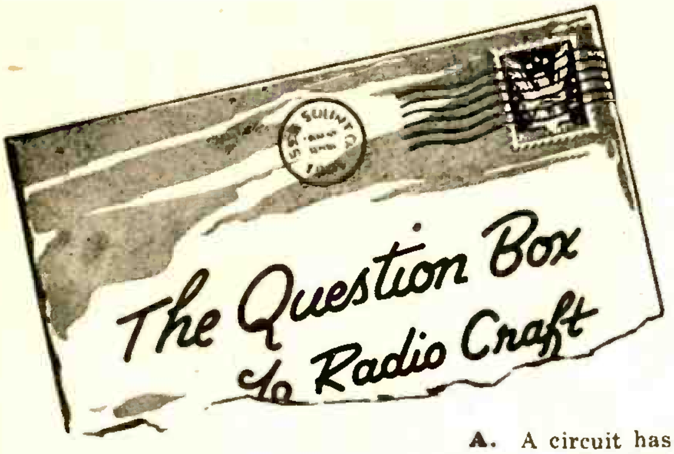
Fig. 1—Components of the mysterious circuit.

half cycle. The electrons charge up capacitor C and a potential varying with the modulation amplitude appears across resistor R. Part of this a.f. voltage is tapped off resistor R and coupled to the volume control through capacitor C_1. The same a. f. voltage exists then between the cathode and the tapping point B, and between the cathode and the top of the volume control V.C. (K-V.C. is equal to K.B.).

If the slider of the volume control is at the top position, all the a.f. voltage between point F and cathode is fed to the grid. As the slider moves to ground less and less of this voltage is tapped off and the input drops to zero if the slider reaches the "ground" position—*but only if the ground has the same potential as the cathode.* Since the cathode by-pass capacitor C_k has a low reactance at a.f., it puts ground and cathode practically at the same potential.

Now Mr. Serviceman should guess from this what happens if C_k is open. He may take the soldering iron again and replace the capacitor. A higher capacity value would do no harm.— *Zygmunt Hof.*

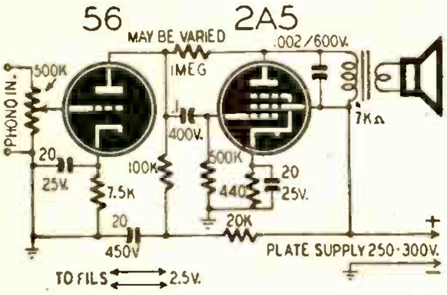
Three members of a Nebraska farm family, arrested for operating an illegal radio station, brought forward the unusual defense that they were using the ether to "spread the gospel." The station, which was heard and located by the Federal monitor station at Grand Island, July 25, broadcast from 12:15 to 1 p.m. daily, carrying religious music, sermons and talks against tobacco and alcohol.



The Question Box is again undertaking to answer a limited number of questions. Queries will be answered by mail and those of general interest will be printed in the magazine. A fee of 50c will be charged for simple questions requiring no schematics. Write for estimate on such questions as may require diagrams or considerable research.

PHONO AMPLIFIER

? *Please print a diagram of a phono amplifier using a 56 and 2A5. I plan to use the amplifier with a 250-volt power supply.—C.J.M., USN, Great Lakes, Ill.*



A. The diagram shown is as specified. The cathode biasing resistor and condenser may be eliminated by grounding the cathode and connecting the return side of the grid resistor to 20 volts negative bias. The output of the amplifier is 4.5 watts with cathode bias and 4.8 watts with fixed bias.

RECORDING AMPLIFIER

? *I would like a circuit of a recording amplifier using a 6SJ7, 6SQ7 and a 6L6, designed to mix the output of a mike and phono pickup. Please include inverse feedback from the output stage to improve the fidelity. I am planning to use a 4-ohm magnetic recording head, and would like to have provision made for aural and visual monitoring.—F.W.H., Philadelphia, Penna.*

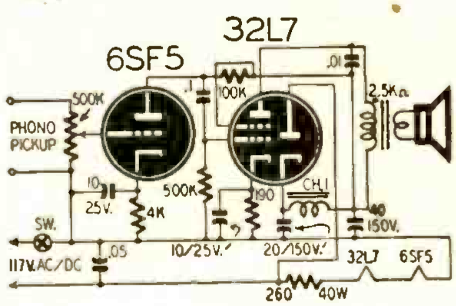
A. A circuit has been drawn to meet your needs. Input voltage from the phonograph pickup is applied to the grid of the 6SQ7 where it is mixed with the output of the mike amplifier. A 6E5 is added as a visual volume level indicator. Its grid is connected to the universal output transformer secondary, the correct tap being found by experiment.

Low impedance headphones connected across the secondary of the output transformer will permit aural monitoring. The degree of inverse feedback is determined by the value of the feedback resistor R. The monitors are connected to the tap on the secondary of the output transformer that will give the proper monitoring level.

If the inverse feedback circuit causes oscillation, reverse the leads of the output transformer to change the phase of the feed-back voltage.

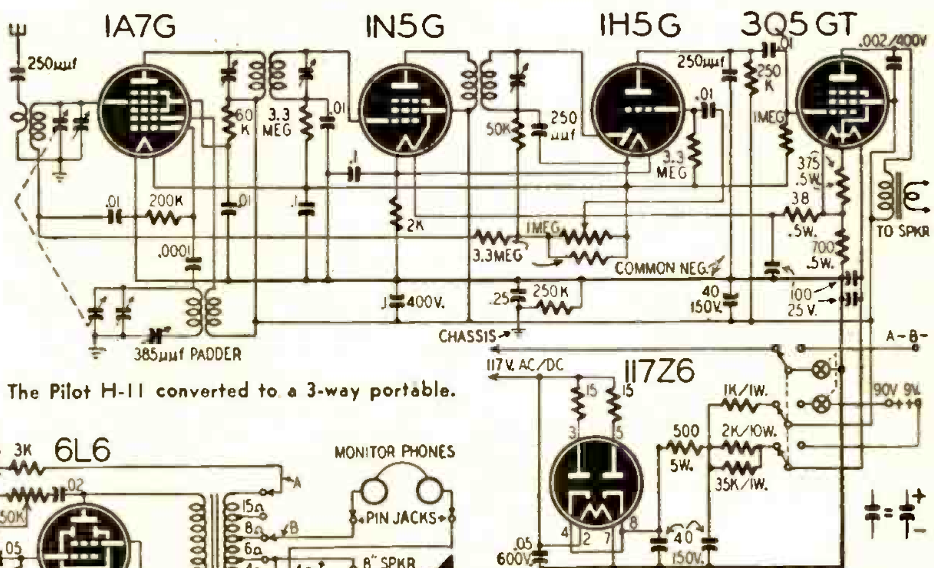
PHONO AMPLIFIER

? *Kindly print a diagram of a small a.c.-d.c. phono amplifier using a 6SF5 and a 32L7.—P.S.W., Canal Winchester, Ohio.*

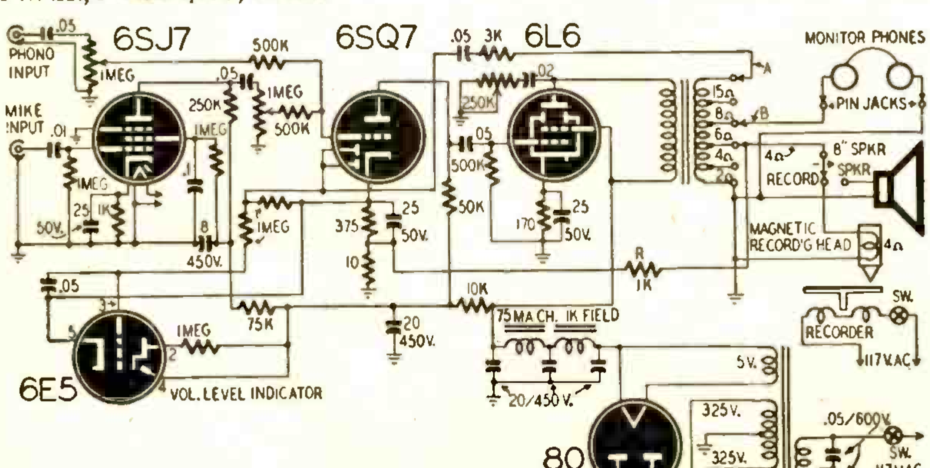


A. The diagram shown has been prepared for you. The same circuit may be used with a 6C5 or 6J5 voltage amplifier coupled to 25A7. If the latter tubes are used, cathode bias resistors will have to be changed to 4000, 6000 and 600 ohms respectively for 6J5, 6C5 and 25A7.

PILOT H-11 CONVERSION



The Pilot H-11 converted to a 3-way portable.



Recording amplifier. Universal output transformer permits matching any recording head.

? *I have a Pilot Model H-11 battery set and would like to add a 117Z6 as a rectifier to supply A and B voltages.—W.R.R., Jamaica, N. Y.*

A. A diagram for converting the Pilot to three-way operation is shown. A 3Q5 has been substituted for the 1C5 as it will perform better in an a.c.-d.c. set. A common negative return has been used for general safety when operating from an a.c. line.

A PRECISION INSTRUMENT
(Continued from page 19)

self admirably to extension of its range through the "vernier" effect upon P1 of adding R4, R4a into circuit to cover from 10 to 1000 μf or megohms.

Voltage for operation of the bridge itself is supplied through special transformer T1 connected to the horizontal bridge arm junctures. Balance is indicated by the absence of voltage across the vertical bridge arm junctures (ground and arm of S1) indicated by the 6E5 electron-ray tube, with the null voltage amplified by the 6SN7GT triode to its left in Fig. 1. Indicator sensitivity is controlled by potentiometer P2.

The power transformer provides heater voltage to the three tubes, and has its high voltage secondary connected as a whole to the 5Y3GT rectifier tube used as a half-wave rectifier. Filtration is a simple problem in this type of instrument, while such use of an essentially standard power transformer and rectifier tube permits obtaining something over 500 volts d.c. output simply and easily. For operation of the amplifier and indicator tubes this is cut down to 200 volts by the voltage divider R10, R10a. The full 500 volt d.c. output of the power supply appears across extra-heavy potentiometer P3, with any panel-calibrated portion of this voltage from 0 to 500 volts obtainable from its arm for application to the capacitor—or resistor—under test through filter resistor R9, PUSH TO POLARIZE button switch S4, and isolating-current limiting resistor R5. C5 through C5f are all 8 μf, 350 working volt electrolytic capacitors. C5d, C5e and C5f in series are the filter input capacitor of 1050 volts rating for the 500 volt circuit voltage—ample safety indeed against line surges. Voltage distribution across them, as well as across C5a, C5b and C5c is held constant and capacitor life is prolonged by shunt resistors R7a, R7b and R10b, R10c and R10d.

Switches S2, S2a shift the function of the 6E5 indicator tube from that of a bridge balance (null) indicator over into a two-range milliammeter with resistor shunts R11 and R12 yielding 0-10 and 0-100 ma ranges. The 6E5 connected across one or both of these resistors in series with the internal d.c. polarizing voltage source and the specimen under test provides a milliammeter which may not be burned out like the ordinary meter movement if a short-circuited condenser is inadvertently tested.

"Where extremely precise measurement of the leakage current through capacitors under test may be required, a more accurate indicator than the 6E5 is preferred. The milliammeter in any conventional volt-ohm-milliammeter may be employed for such precise measurement. It is merely necessary to connect such milliammeter between the capacitor under test and the black jack of the bridge. The meter should be short circuited for all except leakage current measurements, for its resistance can upset power measurements."

SOUND SYSTEM IMPROVEMENT

(Continued from page 21)

closure of this type, the back wave of the speaker is added in phase with the front wave through the port in the cabinet, which adds to the acoustic power obtainable at low frequencies. As a matter of fact, the radiation from the port exceeds the radiation from the cone at very low frequencies. This increases the low-frequency response, extending it approximately an octave lower, while at the same time more heavily damping the frequencies above this point. This tends to smooth out the response from the lower limit up.

Damping material is placed in the baffle behind the speaker to absorb the back wave. If this were not done, it would reflect from the back and cancel some of the higher frequencies emerging from the cone. This would give rise to very uneven high-frequency response. The overall effect is an enormous improvement in the bass and a clean high frequency response.

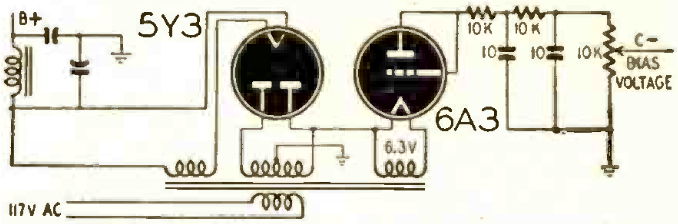


Fig. 5—Simple bias supply which works from the power transformer.

The baffle in Photos A and B was built for an 18-inch speaker, but this type of baffle works its wonders on any size speaker. Fig. 6 gives the dimensions for all standard size speakers. The enclosure should match your individual speaker. The dimensions given are approximate and there are two ways to vary the box's resonant frequency.

The easiest method is to vary the port size by placing a book over part of it while feeding several volts of 60-cycle a.c. into the speaker voice coil from a filament transformer. When the proper size is arrived at, a piece of wood may be screwed over part of the port inside the box. The right position is where the greatest amplitude appears at 60 cycles.

The more difficult method is to move the back of the baffle in or out of the box until the desired result is obtained. For the 15 and 18-inch speakers it would be desirable to use a 30 or 40-cycle source for adjusting the baffle. The source should be a high-quality audio oscillator, with low distortion.

For AM or shellac pressing reproduction, a single speaker with response up to 5000 or 7500 cycles will be adequate. For FM or transcription reproduction, better results can be obtained with a dual speaker system, with a small high-frequency speaker added to extend the range of the larger unit. Several coaxial units are available, ranging in price from $30 to over $250.

Photo C shows a Jensen 18-inch low frequency speaker, a 14-inch speaker and a Jensen C3 tweeter. This combination is capable of reproducing the entire range from 30 to over 15,000 cycles.

The best place for a speaker in any room is in a corner facing the longest diagonal of the room. In this position

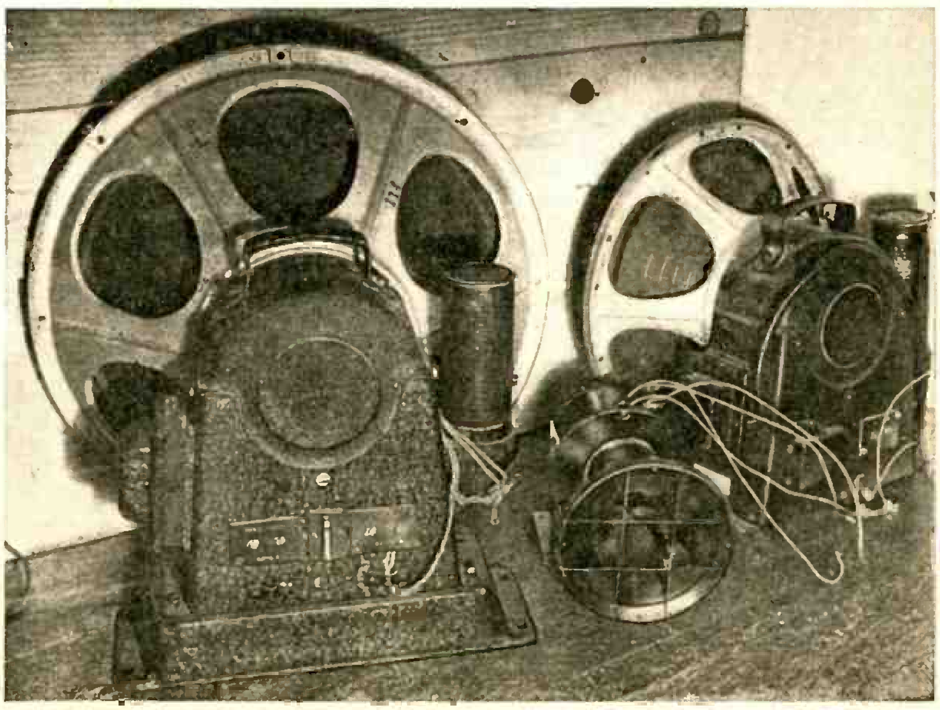
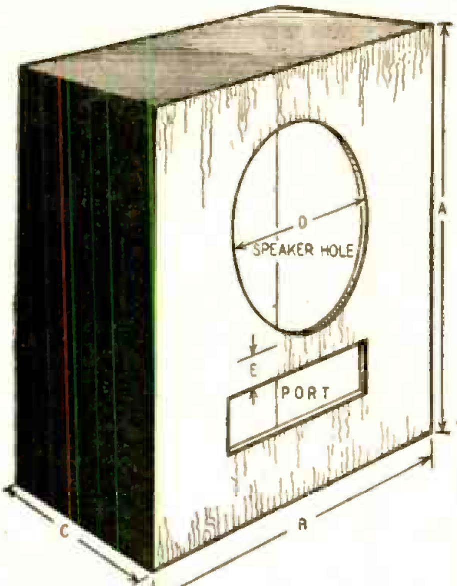


Photo C—A combination of speakers to provide high fidelity from 30 to 15,000 cycles.

the enclosure is best able to match the room's acoustic impedance. Remember to place the speaker far enough from the turntable so acoustic feedback will not occur from mechanical coupling at low frequencies.

Don't ruin records with worn needles. A regular steel needle will play one side of a 12-inch disc and should not be used further, as it will develop a pronounced flat spot with a sharp cutting edge which will tear up the next record.



DIMENSIONS BELOW IN INCHES

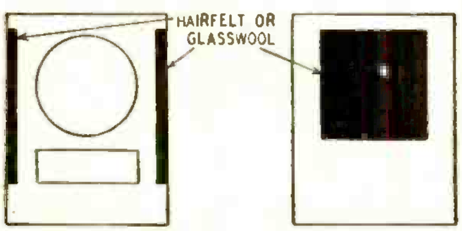
S	A	B	C	D	E	PORT
8	24	18	11	7	3	1/2 AREA OF SPEAKER HOLE "D"
10	28	22	12	9.5	3	" " " " " "
12	31	24	13	11	3.5	" " " " " "
15	34	26	14	13.5	4	9/16 " " " " "
18	40	27	14	16	4.5	5/8 " " " " "

"S" COLUMN SHOW SPEAKER DIAMETERS

Fig. 6—Correct dimensions of speaker baffle (The first column "S" is diameter of speaker).

It will also allow the pickup to chatter in the groove, giving rise to a particularly obnoxious type of distortion.

It is a good investment to purchase a pickup with a built-in permanent stylus. The pressure on the record of these units is usually less than the replaceable-needle types. There is much less acoustical chatter, the hiss is lower and the sapphire stylus is kinder to your records.



Suggested placement of sound-absorbing areas.

In the case of transcriptions, it is necessary to use a light-weight pickup, preferably with sapphire or diamond needles. The one greatest cause of surface noise on records is dust. They should be stored in dustless envelopes. If they get dusty, wash them in water. A dusting brush, which can be purchased in any record shop, is a good investment.

THE TELE-THEATRE

(Continued from page 13)

of the actors on the stage of the Theater Guild, and showed this performance on the television screen of the *Broadway* Theater. *This, then, was the first time in history that two theatres were connected together by means of television.* The results were quite satisfactory. What has been done on a small scale here, will be done on a tremendous scale in the very near future by the instrumentality, which I now term the "Tele-Theatre."

Imagine a special building, erected in the City of New York, for the sole purpose of supplying the entire country with its daily theatre program—not, mind you, motion pictures, which are a "canned" product, but an *actual* theatrical performance just as it is being produced at the exact time on the New York stage.

In order to do so, I visualize a building which will have a series of stages, grouped around a central shaft or pit. There will be stage 1, stage 2, and as many stages as required. The idea of the multiplicity of stages is, that I propose to move the actors rather than move the scenery. At the present time it is necessary for the actors to go behind or before the curtain, when scenes are shifted; which is awkward and always takes up an amount of time for which the public in the future will not stand.

In the central pit we have the stage director at the top of a skeleton steel structure with his assistant technical directors. Stage No. 1 is lit up and the orchestra located immediately beneath the director starts to play. Below the orchestra are a "battery" of television transmitters. Microphones are located in the wings in strategic positions. Television transmitters are connected to a wire network radiating to all parts of the country, just as the wire network transmits radio broadcast programs to the different radio stations in the country now. (Note: *This was written before the invention of the co-axial cable, which probably will be used instead of wire lines. H.G.)*

In Boston, Chicago, Atlanta, San Francisco, and hundreds of other points, we will have local theatres where, for 50c, audiences are assembled nightly to see the latest Broadway production. Instead of 1,500 or 1,600 people seeing the "Follies," five or ten million people will view them nightly, for one week, or for as long a time as the show is put on by the producers. Immediately the undertaking becomes tremendously lucrative, because millions now support a production; whereas before only hundreds did so, at prices which only the rich can afford.

In the Tele-Theatre, we will, of course, have *both sight and sound,* and the audience will actually see and hear their favorite actors at the exact time when the production is being performed in New York. And, of course, it will even be possible to have the actors enjoy the applause, because microphones in the Tele-Theatre will pick up the sounds of the applauding audiences and convey the sounds back to New York; so the actors will have the satisfaction of the applause which is now missing, so much to their detriment, in motion pictures.

Naturally, there will be a number of Tele-Theatres in the larger cities, all supplied by the central theatre in New York; so that, if you wish to go out in the evening, you need not see a musical show if you do not wish to do so. You may, instead, see a "comedy" or "straight-drama" in another Tele-Theatre in your own town, because New York City will telecast a multiplicity of productions for the same evening.

I need not mention that the productions of the future will be on an unparalleled and prodigious scale, never approached before; for the simple reason that, when millions are to view the same performance, naturally it can be ever so much more elaborate.

And, to satisfy remote points such as the West Coast, duplicate performances must be put on later in New York, on account of the difference of time. Thus, for instance, a man in San Francisco will be seated at 8 o'clock (his time), which is 11 pm in New York, when the second performance for the West starts.

THE POSTWAR RADIOS

(Continued from page 30)

GT power amplifier stage, which drives a 4-inch PM speaker.

The rectifier is a 35Z5-GT connected in a conventional half wave circuit working into an R-C filter consisting of a 2200-ohm resistor and the 70-μf capacitor.

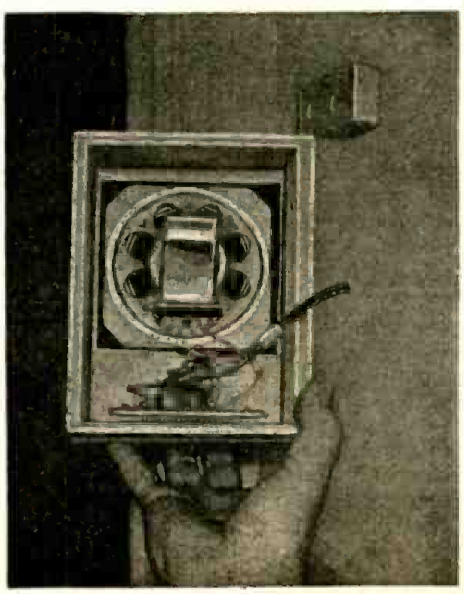
The tuning knob, ¾-inch in diameter, is too small for tuning in any but local stations. These cannot be selected with a great degree of accuracy on the tuning dial calibrated at 55, 65, 80, 100, 130, 150 and 160. In each case, the last zero has been omitted so that 130 on the dial indicates the correct setting for receiving a station on 1300 kc.

HOME INTERCOMMUNICATOR

Continued from page 17)

leads of T1, however, is inserted a resistor R6, and the by-passing switch S1 and one pair of relay contacts. S6 and another pair of relay contacts open or close the power supply B-minus connection to ground. When S1 and S6 and both circuits of the d.p.s.t. relay are open, the plate voltage on the tubes is removed and the filament voltage is cut down to approximately half normal value. This is the standby condition, and allows almost instantaneous use of the amplifier, but conserves tube life when idling. Using a 800-ohm resistor for R6, the idling filament voltage will be about 3.4 volts. R6 is a 20-watt wire-wound unit. This results in a warm-up period from idle condition to full gain of approximately five seconds. This waiting time, starting from cold tubes of the type described, is longer than fifteen seconds. Placing R6 in the transformer primary, rather than the proper value in the filament leads, avoids excessive heating of T1 under continuous operation, and eliminates all transformer hum while idling. (Transformer hum,

(Continued on page 69)



An interior view of one of the substations.

TELEVISION FOR TODAY

(Continued from page 25)

the other end was stretched back and forth. Too great an increase in control will produce a thin, watery image; too low a setting will give a relatively dark image with little variation in light values.

AUTOMATIC GAIN CONTROL

In addition to the manual contrast control, many receivers incorporate automatic gain control. Its counterpart in present broadcast receivers, is a.v.c.; unlike conventional receivers, however, a.g.c. and the contrast control are almost invariably linked into one circuit in controlling the gain of the video i.f. stages. In addition, the problem of using the average level of the incoming signal to obtain the required biasing voltage for the a.g.c. is entirely different than what is encountered with a.v.c. To understand why, let us compare the signals of a sound broadcast with those transmitted for television. In the sound broadcast Fig 3, we see that the rectified voltage consists essentially of two parts—the audio component and the d.c. component derived from the carrier. The d.c. voltage thus derived serves as the a.v.c. bias. (We are ignoring the i.f. ripple because this is always by-passed around the load resistor.)

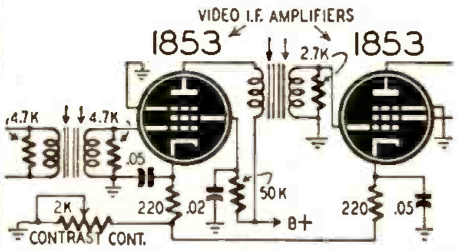


Fig. 2—A simple method of contrast control.

But now examine the television carrier and its rectified voltage, shown in Fig. 4. This contains an a.c. (or varying) video voltage, an average d.c. voltage due to the rectification of the carrier (similar to the d.c. voltage mentioned above) and *one additional* component. It is this additional component that prevents us from using the average d.c. voltage just mentioned. And, strange as it may appear, this additional voltage is also d.c. in nature.

To determine the need for the latter component, let us briefly analyze any scene to be televised. In Fig. 5 we have two identical varying video voltages obtained from one line of an image scanned by the television camera. Note, however, that in Fig. 5-a the average value of the camera signal is low while in Fig. 5-b the average value is higher. In terms of the scene, this difference in average voltage level denotes that both scenes have the same actors, objects and scenery, but that one possesses a greater background or average illumination than the other. The scene with the greater illumination is represented by Fig. 5-a because with negative transmission, the brightest scenes have the lowest voltages. The engineer at the studio control panel regulates the average illumination of the video signal—in accordance with the script—by raising or lowering the average level of the video voltages generated by the scanning beam. He does this by inserting a d.c. voltage. The full video signal, then, contains the a.c. component and an inserted d.c. component. The word inserted is used because this value is generally adjusted by a human element, the engineer.

The video signal, in this form, modulates the carrier and is transmitted. Upon demodulation in the receiver, both these components reappear, together with an average d.c. value due to the carrier. The inserted d.c. voltage, acting with the average d.c. voltage from the carrier, makes it impossible to utilize this latter voltage for gain control, as with a.v.c. The inserted d.c. component varies with each scene and if we used it for a.g.c. the gain would fluctuate accordingly.

CONTROL FOR THE GAIN CONTROL

The source for the regulatory a.g.c. voltage lies in the level of the synchronizing pulses, since it is current practice to raise each pulse to the same amplitude. As long as a carrier retains a fixed strength, the synchronizing pulses will attain the same level. Should the carrier amplitude decrease, due perhaps to atmospheric conditions in the path of transmission, then the strength of each pulse will likewise decrease. Here, then, is an excellent indication of changes in carrier amplitude. In conjunction with a relatively simple diode detector, the corresponding a.g.c. voltage may be readily produced.

The a.g.c. circuit, shown in Fig. 6, is employed in several G.E. sets. One half of the 6H6 is used for the video detector, the other half for a.g.c. In the a.g.c. circuit, we find R1, R2, R3, R4, and R5 with the 0.05-μf condenser connected between R4 and R5. Since the detector half of the 6H6 does not enter into the operation of the gain control circuit, it will be disregarded.

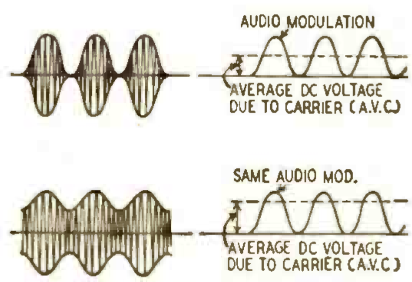


Fig. 3—Audio and d.c. components in carrier.

The modulated video signal is applied to the plate and cathode of the diode, and current flows whenever the plate becomes positive. The path of the current is from cathode to plate through R4, R2,

(Continued on page 68)

UNIVERSAL 1-KW AMPLIFIER

(Continued from page 22)

the instability in high-power beam tetrode and pentode r.f. amplifiers may be due to *electrostatic* coupling between the grid and plate tank tuning condensers as well as electromagnetic coupling between the two tank coils. This point is frequently overlooked and many amateurs construct amplifiers in which only a few inches separate the "hot" tank condenser plates of the two circuits. When the grid tank condenser was placed under the chassis, all troubles from oscillation when using the 4-125As and the HK-257Bs disappeared *in spite of the fact that the grid coil is unshielded.* This arrangement also allows more room on top of the chassis for physically larger tubes such as the RCA 810 or Taylor T125.

Both the grid and plate coils are of the Barker and Williamson swinging-link type. Variable-coupling coils in both the input and output circuits of the amplifier give the unit extreme flexibility and permit the use of almost any exciter which will supply the minimum grid power requirements. The plate coil is a HD type conservatively rated at 1,000 watts; the grid coil is rated at 75 watts. The swinging link assembly is constructed as an integral part of the jack bar. When changing bands it is only necessary to remove and insert the plate coil—the swinging link coil is not disturbed. The adjustable grid coil link is constructed as a part of the plug-in grid coil assembly. In this unit, the link is removed with the coil when it is desired to operate on another frequency band. The grid condenser is a two-section type of 105 μμf per section maximum capacity, spacing 0.045 inch, peak voltage rating 2,000 volts. The plate condenser is also a two-section transmitting type of 99 μμf per section maximum capacity, spacing 0.175 inch, peak voltage rating 7,000 volts.

THE METERING SYSTEM

The milliammeter on the front panel is a 0-50 ma d.c. 3½ inch General Electric type and was obtained from war surplus stock. It is connected into grid and plate circuits by means of the flexible coaxial lead and phone plug and the two jacks along the left bottom of the panel. When the plug is inserted into the jack at the right nearest the small tuning dial, the meter reads directly from the scale and indicates grid current. With the plug inserted into the jack at the left, the meter indicates plate current (or in this unit, the combined plate and screen currents) and the scale readings are multiplied by ten. This is accomplished by placing a suitable shunt across the *plate current jack terminals* which automatically converts the 0-50 milliammeter into a 0-500 milliammeter. About 1.8 ohms of Advance wire are needed. Adjust till meter reads 500 ma full-scale when compared with a standard meter.

The large four-inch dial is the plate tank tuning control; the small dial is the grid tank tuning control.

TUNING-UP PROCESS

Adjustment and operation of the amplifier is simplicity itself. The unit should be perfectly stable and free from spurious radiations or parasitics if the layout shown in the photographs and drawings is duplicated. To place the amplifier in operation:

1. Put the two 4-125A tubes in their sockets and connect the primary of the filament transformer to the 110 volts, 60 cycles a.c. line. Using a good quality a.c. voltmeter, with a scale of *not over 25 volts*, check the filament voltage of each tube in turn *right at the filament terminals of the tube socket.* If the filament voltage is high or low, as compared with the manufacturer's specifications, take steps to correct the condition. The use of a Variac or other voltage-adjusting device is a practical necessity when working with expensive transmitting tubes. The tubes not only will last much longer when operated at the proper filament voltage, but better *r.f. efficiency* will be obtained.

2. With a co-axial line or twisted pair, connect the output link of your exciter to the adjustable link of the amplifier grid coil. Adjust the grid coil link for minimum coupling. *Do not apply plate and screen voltage.* Insert the milliammeter plug into the jack at the right. Connect the proper fixed bias voltage in series with the grid return as shown in the schematic diagram.

3. Apply r.f. excitation to the grid circuit link coil. Rotate the grid tank tuning dial and watch the milliammeter. Grid current will be indicated when the grid tuning control is adjusted to resonance with the excitation frequency. If no grid current or too low a grid current reading is obtained at resonance, move the link toward the center of the coil and carefully retune the grid circuit for maximum grid current indication. When the grid current is of the value specified for the plate voltage in use, carefully "peak" the grid tuning control and leave it alone. NOTE: Unless the r.f. driver stage regulation is very good, the grid current will drop slightly after the plate and screen voltages are applied. After the amplifier is in operation, the link coil may be readjusted to give proper grid current reading with the plate and screen voltages applied.

4. Leave the grid circuit alone. Remove the plug from the grid current jack and insert it into the plate current jack. Connect a 110 volt, 100- to 200-watt lamp across the terminals of the plate circuit swinging link coil to act as a dummy antenna. The plate voltage should be reduced to approximately 1,000 to 1,500 volts for the preliminary tune-up procedure. This may be accom-

(Continued on page 71)

New Radio-Electronic Patents

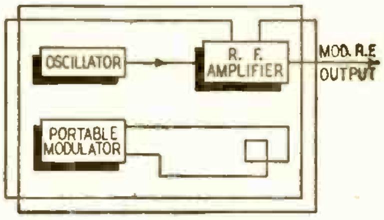
By I. QUEEN

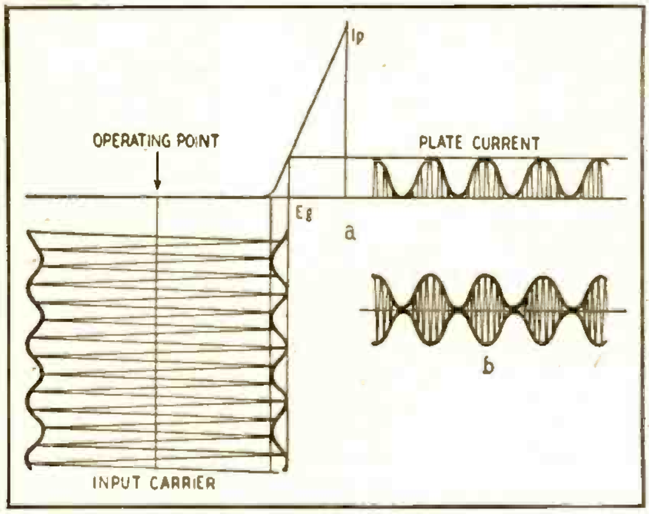
MODULATION STEP-UP

Frank H. Slaymaker, Rochester, N. Y.
Patent No. 2,403,245

This method greatly increases the percentage of modulation of an r.f. carrier. Mobile units such as tank transmitters must operate at very low percentages of modulation due to requirements of portability. For example, in a tank it is possible to include a large loop which creates the r.f. field. Within this field, the operator carries about with him a small loop and portable modulating apparatus. The small loop modulates the r.f. by absorption. Due to the necessarily simple audio equipment possible, the percentage of modulation is very low.

In this invention, the r.f. amplifier is biased so that the modulated portion of the carrier coincides with the lower portion of the r.f. tube characteristic. In this way only the modulated portion is present in the output circuit as shown. This corresponds to 100 percent modulation. The steeper the Eg-Ip curve, the greater the modulated output. Due to fly-wheel action in the plate tank, the half-waves become symmetrical as shown in b.



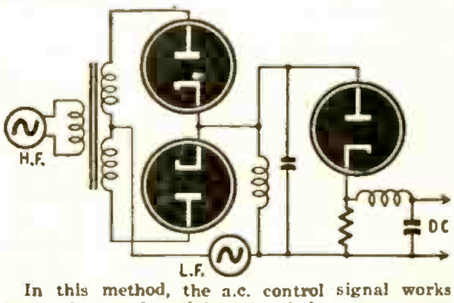


It is evident that the distortion creates harmonics of the original r.f. oscillation. This is an advantage since it is possible to produce 100 percent modulation and multiply the frequency in the same stage to reach the desired high frequency. As long as the modulated portion of the radio-frequency envelope falls on the linear portion of the Eg-Ip curve, no troublesome modulation distortion is introduced at the various harmonics.

CONTROL SYSTEM

James W. Conklin, Indianapolis, Ind.
Patent No. 2,403,053

Control equipment such as for controlling temperature, generally relies upon a d.c. voltage to deflect a galvanometer and thus operate the control mechanism. However, d.c. cannot be conveniently amplified, so a.c. must be used to obtain sensitivity. In general, therefore, the quantity to be controlled, such as heat, velocity, etc., is converted into an equivalent a.c. which must be rectified and filtered. Since this a.c. is usually of low frequency, it requires a large filter capacitance. This results in appreciable and undesirable time delay.



In this method, the a.c. control signal works into a balanced modulator, and does not appear in the output. A high frequency of about 10,000 cycles is applied in push-pull through a transformer. The output of the modulator is tuned to one of the side-bands, which being of relatively high frequency does not require large filter capacitance after rectification. Therefore, the time lag is eliminated.

SERVICING MOVIE SOUND
(Continued from page 24)

this adjustment may be made by running any film with sound recording and adjusting so that frame line flutter will be heard at one extreme and sprocket hole hum at the other. The roller should be centered between the two in the manner described above.

All pad rollers (Fig. 2) should be adjusted so there will be a clearance equal to two thicknesses of film between them and the sprockets on which they run.

The sprocket teeth should be inspected and the sprocket replaced if they show signs of wear. Since the sprocket teeth wear on only one side it is often possible to reverse the sprocket end for end, which places the opposite side of the teeth against the film while pulling, thus increasing the useful life of the sprocket.

(A second article will appear in an early issue)

FM radio is in a quandary in which many stations are transmitting their full allotted time to audiences which approach the vanishing point, said T. R. Kennedy of *The New York Times* last month. Cause of the paradox is the "moving upstairs" of the transmitters, pursuant to FCC order, while most of the present receivers receive only low-frequency FM transmissions.

WORLD-WIDE STATION LIST

(Continued from page 32)

Freq.	Station	Location and Schedule
6.000	XEBT	MEXICO CITY, MEXICO: 8:45 am to 12 am.
6.005	CFCX	MONTREAL, CANADA: 7 am to 11:15 pm.
6.005	HP5K	COLON, PANAMA: 7 am to 3 pm: 7 to 11 pm.
6.005	VE9AI	EDMONTON, CANADA; midnight to 2 am.
6.007	ZRH	JOHANNESBURG, SOUTH AFRICA: 11:00 to 2 am except Saturdays.
6.010	GRB	LONDON, ENGLAND
6.010	CJCX	SYDNEY, NOVA SCOTIA: 5 pm to midnight.
6.018	HJCX	BOGOTA, COLOMBIA: 7 to 8 am; 2 to 11:15 pm.
6.023	XEUW	VERA CRUZ, MEXICO: 7 am to 12:45 am.
6.023	FZI	BRAZZAVILLE, FRENCH EQUATORIAL AFRICA: 4 to 8 pm; midnight to 1:30 am.
6.025	IRF	ROME, ITALY; 7 to 8:15 am; 12:30 to 6 pm.
6.028		MOSCOW, U.S.S.R.: 5:45 to 9:30 pm.
6.028	ZRH	JOHANNESBURG, SOUTH AFRICA: 11:45 pm to 1:30 am.
6.030	CFYP	CALGARY, CANADA; 7:30 am to 1 am.
6.030	HP5B	PANAMA CITY, PANAMA: 6 to 11 pm.
6.030		BERLIN, GERMANY: 2 to 3 am; 4 am to 1 pm (from Russian sector).
6.035	GWS	LONDON, ENGLAND
6.037	OLR2B	PRAGUE, CZECHOSLOVAKIA: 4:30 pm to ?
6.040	WRUW	BOSTON, MASS.; Central American beam, 8:30 pm to 1 am.
6.040		ALGIERS, ALGERIA: 12:30 to 6 pm.
6.040		RANGOON, BURMA: 8:15 to 9:45 pm; 1:15 to 2 am; 6:45 to 8:15 am.
6.040	COBF	HAVANA, CUBA; 8 am to 11 pm.
6.045	XETW	TAMPICO, MEXICO: 7:45 am to 12:45 am.
6.060	WCBN	NEW YORK CITY: Mexican beam, 6:30 pm to 1 am.
6.070	GRR	LONDON, ENGLAND: Central American beam, 8 to 10:15 pm.
6.065		TETUAN, SPANISH MOROCCO: 5 to 6:15 pm.
6.070	CRFX	TORONTO, CANADA; evenings till after midnight.
6.080	WLWK	CINCINNATI, OHIO: South American beam, 7:30 pm to 12:15 am.
6.080	CKFX	VANCOUVER, CANADA: 9:30 am to 3 am.
6.090	GWM	LONDON, ENGLAND.
6.090	LRY1	BUENOS AIRES, ARGENTINA: 5:45 to 7:15 am; 5 to 9 pm.
6.090	ZNS4	NASSAU, BAHAMAS: 7:45 to 8:30 am; 11:30 am to 1:30 pm; 4 to 10 pm.
6.090	CBFW	MONTREAL, CANADA: 7:30 am to 11 pm.
6.095	XRRA	PEIPING, CHINA: 4 to 11 am.
6.095	ZYB7	SAO PAULO, BRAZIL; 4:30 to 10 pm.
6.100	VUD7	DELHI, INDIA: 8:30 to 10 pm.
6.105	PRE9	FORTALEZA, BRAZIL: 3:30 to 6:15 pm Mondays; 3:30 to 8:35 pm other days.
6.110	GSL	LONDON, ENGLAND: Near East beam, 11 pm to 12:30 am; Italian beam, 11 pm to 12:30 am.
6.120	WOOW	NEW YORK CITY: European beam, midnight to 3:15 am.
6.120	KRHO	HONOLULU, HAWAII: Oriental beam, 4 to 9:45 am.
6.122	HP5H	PANAMA CITY, PANAMA: 7 am to 11 pm.
6.125	GWA	LONDON, ENGLAND.
6.128	XEUZ	MEXICO CITY, MEXICO: 3 pm to 12:30 am.
6.130	CHNX	HALIFAX, NOVA SCOTIA: 7 am to 11 pm.
6.130	COCD	HAVANA, CUBA: 7 am to 10 pm.
6.130	VPD2	SUVA, FIJI ISLANDS: Sundays, 1 to 5 am; other days, 3 to 4 pm.
6.135	AFRS	MILAN, ITALY: 11:30 am to 4:30 pm.
6.145	HJDE	MEDELLIN, COLOMBIA: 4 to 10:30 pm.
6.150	GRW	LONDON, ENGLAND.
6.150	CJRO	WINNIPEG, CANADA: 9 to 11 pm.
6.150		BELGRADE, YUGOSLAVIA: 1 to 6 pm.

Freq.	Station	Location and Schedule
6.155	EQB	TEHERAN, IRAN: 9 am to 2:30 pm; 8 to 8:30 pm.
6.155	TIRH	SAN JOSE, COSTA RICA; 9:30 pm to midnight.
6.155	CS2WD	LISBON, PORTUGAL; 4:30 to 7 pm.
6.160	HJCD	BOGOTA, COLOMBIA; 7 am to 8 am; 4 to 11:30 pm.
6.160		MUNICH, GERMANY; midnight to 3 am.
6.160	CBRX	VANCOUVER, CANADA; 6 am to 3 am.
6.165	GWK	LONDON, ENGLAND.
6.165	HHCM	PORT-AU-PRINCE, HAITI; 5 to 8:30 am; 11 am to 2 pm; 5 to 9 pm.
6.165	HER3	BERNE, SWITZERLAND; 8:30 to 10 pm.
6.180	LRM	MENDOZA, ARGENTINA; 5:15 to 10 pm.
6.190	HI1A	SANTIAGO, DOMINICAN REPUBLIC; 4 to 5 pm.
6.198	HJCT	BOGOTA, COLOMBIA; evenings till 11:30 pm.
6.200	YV6RD	CIUDAD BOLIVAR, VENEZUELA; 5 to 9:30 pm.
6.205	CP5	LA PAZ, BOLIVIA; 6:15 to 10:45 pm.
6.205	FK8AA	NOUMEA, NEW CALEDONIA; 2:30 to 4 am; 4:30 to 5 am.
6.230		MOSCOW, U.S.S.R.; noon to 6:25 pm; 7 to 9:45 pm.
6.235	HRD2	LA CEIBA, HONDURAS: 7:30 to 10 pm.
6.240	HJCF	BOGOTA, COLOMBIA; 5 to 11 pm.
6.243	HI1N	CIUDAD TRUJILLO, DOMINICAN REPUBLIC: 4 to 10:30 pm.
6.280	HCJB	QUITO, ECUADOR: 6 to 10 pm.
6.315	HI1Z	CIUDAD TRUJILLO, DOMINICAN REPUBLIC; 4 to 9:30 pm.
6.330	COCW	HAVANA, CUBA: 7 am to 10 pm.
6.345	HEI2	BERNE, SWITZERLAND: 12:40 to 1:40 am; 6:20 to 7 am; 1 to 5:15 pm.
6.345	COKG	SANTIAGO, CUBA: 4 to 11 pm.
6.357	HRP1	SAN PEDRO SULA, HONDURAS: 6 to 7:30 am; 6:30 to 10:30 pm.
6.370	CSX	LISBON, PORTUGAL; 3:30 to 7 pm.
6.455	COHI	SANTA CLARA, CUBA; 7 am to 1 am.
6.465	TGWB	GUATEMALA CITY, GUATEMALA; 8 am to noon; 6:30 pm to 1 am.
6.485	HI2T	MONSIGNOR NOUEL, DOMINICAN REPUBLIC; 4 to 10:30 pm.
6.510	CP40	COCHABAMBA, BOLIVIA; 7:30 to 10 pm.
6.620	TG2	GUATEMALA CITY, GUATEMALA; 6 to 11 pm.
6.720	PMA	BANDOENG, NETHERLAND INDIES: 5:30 to 9:30 am.
6.715	ZLT7	WELLINGTON, NEW ZEALAND; 4:25 to 4:45 am.
6.750	JVT	TOKIO, JAPAN: to U.S. at 2 to 8 am.
6.760	YNDS	MANAGUA, NICARAGUA; 8 to 10 am; 5 pm to 12 am.
6.770	CP49	LA PAZ, BOLIVIA: 7 to 9 am; 11 am to noon; 6:30 to 9 pm.

(Continued on page 62)

Production of electricity from atomic piles is expected within the next eighteen months, scientists of the Oak Ridge Laboratories state. Electricity will be produced for experimental purposes only, not on a commercial basis.

WORLD-WIDE STATION LIST
(Continued from page 61)

Freq.	Station	Location and Schedule
6.850	YNOW	MANAGUA, NICARAGUA; 8 am to midnight.
6.980		MOSCOW, U.S.S.R.; 5:45 to 6:25 pm; 7 to 9 pm; 11:15 to 11:45 pm.
6.980	FO8AA	PAPEETE, TAHITI; Fridays and Saturdays, 10 to 11:30 pm.
7.008	YNBH	MANAGUA, NICARAGUA; 6 to 10 pm.
7.010	XPSA	QWEIYANG, CHINA; 11:30 pm to 1 am; 5 to 10 am.
7.018	YNWW	GRANADA, NICARAGUA; 1 to 10 pm.
7.080	HI2A	SANTIAGO, DOMINICAN REPUBLIC; 10 am to 1:30 pm; 4:30 to 8:30 pm.
7.100		BISSAU, PORTUGUESE GUINEA; 5 to 5:30 pm.
7.120	GRM	LONDON, ENGLAND; Australian beam, 1 to 3:45 am; New Zealand beam, 1 to 3:45 am.
7.140		VIENNA, AUSTRIA; midnight to 2 am; 6 to 8 am; 10 am to 4:30 pm.
7.153	XGOY	CHUNGKING, CHINA; 6:30 to 10:30 am.
7.160	HCIBF	QUITO, ECUADOR; 6:45 to 11 am; noon to 2 pm; 5 to 11 pm.
7.160		VIENNA, AUSTRIA; midnight to 2 am; 6 to 8 am; 10 am to 8:30 pm.
7.190	JCPA	CAIRO, EGYPT; 3 pm to ?; 10:30 pm to midnight; 2 to 3 am.
7.210	FGY	DAKAR, FRENCH WEST AFRICA; 1:15 to 1:45 am; 2 to 2:30 am; 1:45 to 4:25 pm.
7.215	FG8AH	POINTE-A-PITRE, GUADELOUPE; 6 to 7:30 pm.
7.215	VLQ2	BRISBANE, AUSTRALIA; on at 6:15 am.
7.205	EAQ	MADRID, SPAIN; heard 9:30 to 10 pm.
7.220	JCKW	JERUSALEM, PALESTINE; 10:30 pm to 3 pm.
7.220		SINGAPORE, MALAYA; 11:30 pm to 1:30 am.

SOUND ENGINEERING

(Continued from page 31)

6.3-volt heater winding for the 6L6G output tubes—2 amps.

The remaining 6.3-volt winding is rated at 3 amps.

If you have any difficulty in locating a transformer with these secondary voltages, you might be able to construct one yourself or possibly have it built in accordance with the following manufacturing specifications:

Transformer Core—1½ x 2¼-inch Transformer Grade.

Primary—218 turns of No. 19 wire.

Electrostatic Shield.

High-Voltage Secondary—1520 turns center-tapped No. 30 wire.

Bias Secondary—750 turns center-tapped No. 30 wire.

5-volt 3-amp. winding—10 turns center-tapped No. 16 wire.

6.3-volt 3-amp. winding — 13 turns center-tapped No. 16 wire.

5-volt 2-amp. winding — 10 turns center-tapped No. 18 wire.

6.3-volt 2-amp. winding — 13 turns center-tapped No. 18 wire.

The high voltage winding should be insulated from other windings and core to withstand 1750 volts RMS 60 cycles. The bias winding should withstand 1500 volts. The 5-volt 3-amp winding should withstand 2,000 volts.

HUM PICKUP, LINE IMPEDANCE

The Question . . . .

I am operating a sound moving picture system in an auditorium and have considerable trouble with hum at the loud-speaker and boominess. The room is not treated acoustically but some portable machines that have been operated there give satisfactory results.

The output of the amplifier (push-pull 2A3's) is coupled to the line through a "2A3 P-P to 500-ohm" transformer. The line is made up of a pair of No. 14 flexible wires, twisted, with heavy insulation, and is about 250 feet long. It terminates in the primary of a 500-ohm-to-voice-coil transformer. The line is unshielded and the speaker, when plugged in at the amplifier, shows no sign of hum. The amplifier is well grounded. The monitor speaker, a pm dynamic, shows lots of hum also when the main speaker is coupled to the other end of the line.

I am at present experimenting with the input end, photocell lines, etc., to see how much hum is originating there.

In connection with the output end, I would like to know how the impedance of an audio frequency line may be computed. Have tried feeding the line with and terminating it in 250-ohm transformers but did not get as good results as with 500-ohm terminations.

GEORGE F. SWARTZ
San Francisco, Calif.

The Answer . . . .

The excessive boominess you mention is undoubtedly caused by an extended

(Continued on page 64)

When writing advertisers, please mention that you saw it in RADIO-CRAFT.

SOUND ENGINEERING

(Continued from page 63)

low-frequency response in the entire reproducing system. If other machines operate satisfactorily in the same auditorium, you undoubtedly can correct the trouble with your particular machine, by reducing the low frequency response of either the amplifier or the loud-speaker.

The hum may be picked either by the long unshielded line, particularly if it runs parallel to some power line carrying high currents, or, the coupling transformer at the speaker may be picking up hum from some hum-producing equipment on the stage of the auditorium. The fact that no hum is noticed in the monitor speaker when the auditorium speaker is connected directly at the amplifier, indicates that the hum is not being produced at the input end of the amplifier. An increase of hum in the PM speaker (at the amplifier) when the stage speaker is connected at the remote end of the line, clearly indicates that the line circuit is involved in the hum pickup. You can check if the speaker coupling transformer is picking up the hum by orienting the speaker while it is on the stage to see if the hum is reduced. If not, I suggest that you either shield the line or re-locate it so as to keep it away from high-current-carrying power lines.

The impedance of a terminated audio

frequency line may be checked with a power output level indicator. This device should be connected at the remote end of the line and adjusted so that maximum transfer of power takes place. The impedance setting of the indicator shows the proper terminal impedance.

The impedance of a non-terminated line is a function of its distributed capacity, inductance, d.c. resistance and insulation characteristics. For rough approximations, the impedance of a line should be at least twenty times its d.c. resistance. The distributed capacity of the line should have a capacitative reactance, at the highest frequency which the line is to transmit, of at least ten times the impedance of the source. The 250-foot line that you describe should be suitable for impedances ranging from 25 to 250 ohms, if 10,000 cycles is the upper frequency limit of transmission, or 25 to 500 ohms, if 5,000 cycles is the upper frequency limit.

The fact that you did not get as good results with 250-ohm terminations should not lead you to any false conclusions. The 250-ohm termination may have added some undesirable high frequency response in the system, and possibly provided less pleasing results. On the other hand, the 500-ohm transformers may have been much more efficient.

MAGNETOSTRICTION PICKUP

(Continued from page 16)

rants record performance beyond these limits—when such recordings can be obtained.

The pickup coils are so small they are not affected by magnetic fields that may exist around a phonograph motor or associated power lines. This factor reduces pickup hum to a negligible degree. The pressure on the needle point is only 0.7 ounce. This tends to reduce record wear and surface noise.

The TM pickup has a low output impedance, making it necessary to employ a coupling transformer between the pickup and the grid circuit of the amplifier. A high-quality transformer, correctly matched to the pickup and input grid circuit, will make it possible to take advantage of the high-fidelity recordings and transcriptions that are currently available.

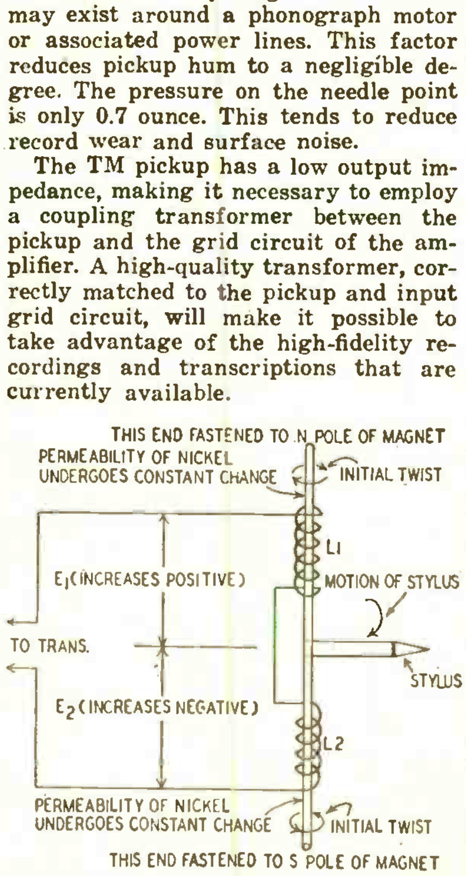


Fig. 2—Diagram of magnetostriction pickup.

BEAT-FREQUENCY OSCILLATOR

(Continued from page 28)

2000-ohm 5-watt resistor instead. Large filtering condensers and the extra filtering for the 6V6 screen also help. Ground returns are made to the No. 1 pin of the associated tube, all No. 1 pins being connected directly to the chassis by a short length of thick copper wire.

The plan view (Fig. 2) shows the general layout, with two tubes at each end (note the separation of 6K7 and 6J8) with a small vertical (40 milliampere) power transformer in between.

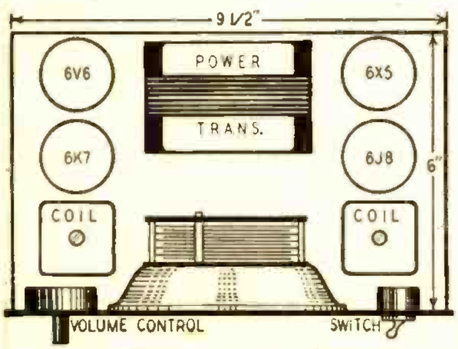


Fig. 2—The above layout should be followed.

Before any parts are mounted, the grid leaks and condensers must be connected inside the coil cans, the 6J8 triode decoupling arrangement also going inside a can if there be room. Chassis depth is only 2 inches, though this can be increased to 2¾ inches if bantam tubes are used.

The main variable condenser moving plates are filed away at the end which first meshes, as shown in Fig. 3, and the fixed plates are shifted farther from the shaft. The idea is to have only a very, very, slow increase in capacity at first. Half the moving plates are to be removed—usually they can be pulled out without much trouble.

The front panel is of Masonite with a crackle-black finish. A bracket going right across the back of the panel carries the dial, dial drive and variable condenser. Four thick metal-braid leads run from the condenser to the chassis.

The dial drive consists of a large pulley on the condenser shaft with a quarter-inch diameter spindle fitting in a hollow bolt in the lower right-hand end of the panel. To provide a good grip for the dial cord, a strip of adhesive tape is wrapped around the end of the spindle.

The zero-set 3 plate condenser must be shielded by a screen of steel, brass or copper.

ADJUSTING THE OSCILLATOR

If the oscillator fails to produce a sound when a PM speaker or a pair of phones is connected to the output there may be several explanations. Incorrect polarity of one or more feedback coils (the plate windings) may prevent oscillation, one test for lack of oscillation being the absence of a negative voltage on the innermost grid of the tube concerned.

Another possibility is that the frequency difference of the oscillators may be so high that the sound is inaudible. This is the usual fault and is due to the small .001 μf condensers having incorrect values. Try shunting *one* of them at a time by .0001, .0002, and .0003 μf condensers. As a last resort a trimmer or padder condenser may be needed, but that is very undesirable as they do not stay put sufficiently and cause bad drifting especially when the weather varies.

ADJUSTMENTS FOR QUALITY

Once the oscillator is working, the next step is to obtain good wave-form by reducing the shunt resistor between the 6K7 screen and chassis. Try shunts of 1, .5, .25, .1 meg., etc., until oscilla-

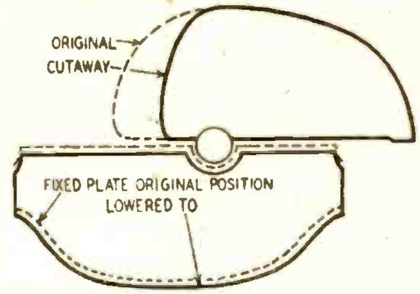


Fig. 3—How the condenser plates are shaped.

tion stops. Then connect in the smallest standard size that allows operation. This adjustment should be made at a fairly high frequency, say around 1000 or 2000 cycles and is facilitated if a cathode-ray oscilloscope is at hand to observe the waveform. Now the oscillator tuning control should be manipulated to determine the lowest possible frequency that can be produced. If locking-in occurs at too high a frequency, it may be due to imperfect grounding of coil cans, insufficient screening around gang, presence of r.f. in the output (cured by shielding of 6V6 together with a .00025-μf condenser from 6V6 plate to chassis) or an open by-pass condenser somewhere. Reduction in size of the 6K7 coupling condenser from .0005 to .0002 μf (or smaller) may help keep the circuits independent.

The particular oscillator shown had a wooden case and provided frequencies lower than 10 cycles per second. When a metal case is used, even lower frequencies can be obtained but care in shielding and wiring layout is most important. Frequency response of the output can be adjusted slightly by varying the capacities of the four condensers associated with the 6V6.

Calibration is best performed against an already calibrated oscillator by means of *Lissajou figures* on an oscilloscope, but other methods such as by beats and by bridges are also possible. Very accurate calibration at 20, 30, 45, 60, 90, 120, 150, 180 cycles can be obtained from an accurate 60-cycle supply.

TRANSATLANTIC NEWS

(Continued from page 29)

one of yours reference must be made to a comparative table of wire gauges before the inductors can be wound, for your B. & S. and our S.W.G. are quite different. I remember once winding a large solenoid with No. 30 wire as per instructions and wondering why there was not room on the former for all the turns. Then I realized that No. 30 was B. & S., equivalent to our No. 33.

BIG POSSIBILITIES

Two recent American developments have made a big impression on technical folk over here. These are the subminiature tubes and the system of painting connections with silver solution instead of using wires. I have heard of engineers who are contemplating special trips to the U.S.A. to investigate just these two things. What hurts me more than I can tell is that I got the idea of painting connections on radio panels about 20 years ago. I spent a lot of time and a good deal of money in buying and trying out every kind of metallic paint I could lay hands on. The only result of all that work was the discovery that most of them were pretty good insulators!

THE TENSION FILE?

Is the tension file available in your country? If it is, I can recommend it as a very handy tool for the radio workshop. As the drawing shows it is a round file about one-sixteenth inch in diameter, made with a knob at each end. To use it you fit it into an ordinary hacksaw frame by means of a pair of special clips and tighten it up just like a hacksaw blade. You then have what is to all intents and purposes a metal fretsaw. With the tension file you are not confined to cutting along straight lines, as you are with a hacksaw. You can cut curves, or even turn corners at a sharp angle. In fact the tool enables one to do a thousand and one neat shaping jobs which were previously almost impossible in the average amateur workshop. In England the files are obtainable in three different cuts, coarse, medium and fine.

NEW RADIOS

New radios are slow in coming along. Our radio industry shut down on the manufacture of domestic radios in September, 1939. Result is that the vast majority of the radios in use in Britain today date from 1938 or even earlier. There is no large supply on the market yet, for the government insists that a big percentage of those produced should be earmarked for export. Most of the sets in the shops are small and simple types which show little advance on prewar designs. One reason is shortage of both components and materials, owing to the need of wood, plastics, metals and labor to erect and equip the houses now being built to replace some of the millions destroyed during the war. However, we are promised better things in the fall!

TELEVISION FOR TODAY

(Continued from page 56)

and R3 back to the cathode by way of the secondary of the I.F. transformer. As a result of the current flow, a voltage is developed across R4 with the polarity indicated. Since the incoming video signal has a negative picture phase the plate reaches its greatest positive value at the blanking and synchronizing pulses. The greatest current flows at this moment and develops the greatest voltage across R4. The video portion of the signal drives the diode plate only slightly positive and results in a relatively small amount of current flow.

The voltage that appears across R4 is the a.g.c. voltage. It is applied from grids of the tubes to be controlled through the filter composed of R5 and the 0.05-μf condenser. The filter has a relatively long time constant ($T = RC = 0.0005$ sec.), existing for about 10 horizontal lines. With this time constant, the 0.05-μf condenser, which is effectively across R4, charges to the peak value of the voltage across the resistor and retains this charge for a relatively long time. However, the peak voltage across R4 is determined by the synchronizing pulses of the video signal. Hence, the condenser charges to this peak voltage and then discharges so slowly that the rapid variations due to the smaller image voltages are ineffective and never reach the grids of the controlled tubes. Only changes in the level of the synchronizing pulses are effective at the preceding tubes. This is the desired action because, with constant carrier signal strength, the peak pulse voltages are also constant. With no signal arriving at the receiver, no voltage is developed across R4.

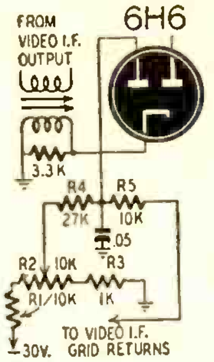


Fig. 6—A gain control.

The plate of the a.g.c. diode and the grids of the controlled tubes are negatively biased by a voltage obtained from the negative side of the power supply. This voltage is in addition to the negative a.g.c. voltage and represents the minimum fixed bias on the tubes. There is –30 volts between the end of R1 and the grounded side of R3. Approximately 13 volts appear across R1, leaving the remaining 17 volts for R2 and R3. Rotation of the center arm of R2 will permit adjustment of the amount of negative voltage placed on the diode plate and on the controlled tubes' grids. In this way the amount of a.g.c. voltage fed back to the grids can be controlled. In addition, the d.c. negative bias of the grids may be altered, resulting in more or less gain for the video signal passing through the set. With greater gain, a stronger video signal is applied to the grid of the picture tube and a greater degree of contrast is obtained.

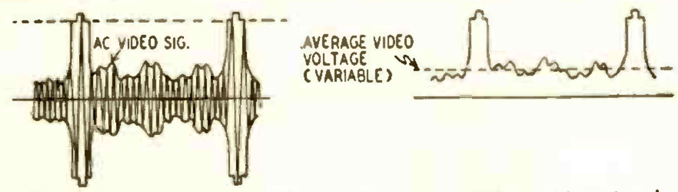


Fig. 4—Modulated television carrier and rectified video signal.

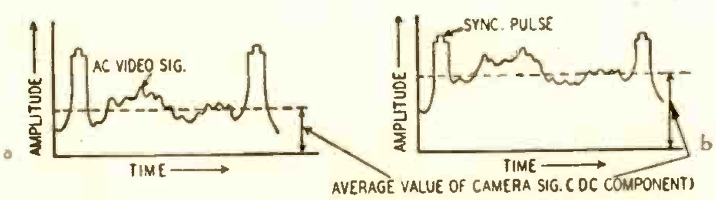


Fig. 5—Two identical video signals may differ in brightness only.

CORRECTION

No wire sizes were given on the coil table of the Signal Generator, on page 778 of the August issue. A revised coil table with wire size is:

Band (kc)	Turns	Tap	Wire size
100-300	500	150	30 enamel
300-900	180	45	28 enamel
900-2700	46	10	28 enamel
2700-8100	17	3	28 enamel
8100-24000	5.2	1.4	26 enamel

A 2.5 millihenry r.f. choke, tapped between the first and second pies from the bottom may be used to cover the 100-300 kc band.

We are grateful to Mr. L. Donivan, of Bronx, N. Y., for calling our attention to the omission of wire sizes.

HOME INTERCOMMUNICATOR

(*Continued from page* 55)

although slight in a good unit, can still be objectionably loud in the quiet of a bedroom at night.)

S1 and S6 are ganged with S4 and S7 in the form of a four-pole two-position lever action positive type twitch. S7 makes or breaks the 6.3 volt leads to the pilot light. The function of S4 will be treated in the following paragraph.

In each substation is located a double-pole single-throw switch in the form of a spring-return push button. These switches are normally open. When closed, one side completes the relay coil energizing circuit, thus closing both pairs of relay contacts. This, in turn, applies B voltage to the amplifier and brings the filament voltage up to normal level. The other side of the substation push-button switch connects the substation speaker voice coil to the amplifier input, through S4. This connection by-passes the regular voice coil leads and the master station selector switch S3, thus allowing the substation to call the master station even though the latter's power switch is "off," and the selector switch is set to the wrong position. If the ensuing conversation is of any length, the master station operator may set the station selector switch properly and throw his power switch to "on," thus relieving his fellow conversationalist of the duty of holding in the push button. When the master station power switch is turned "off" upon completion of the conversation, S4 is returned to position.

The other side of the substation

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HOME INTERCOMMUNICATOR

(Continued from page 69)

speaker voice coil is grounded to a water pipe, as is No. 6 pin of the amplifier connecting plug. The water pipe system cannot be used as one of the relay leads as well as a return for the audio signal because of the coupling between the two circuits when the relay circuit is closed. This interaction would cause intolerable distortion.

CONSTRUCTION DETAILS

The 9¼ by 7 by 2-inch chassis was built for the job of 22 gage galvanized sheet. A metal chassis front was provided for mounting the controls and speaker so that the cabinet front could be made an integral part of the box. A standard chassis and panel could have been used. The usual precautions in separating the input circuit from the rest of the amplifier should be followed. The power and interstation leads enter the master set through chassis-mounted connectors so that the amplifier may be easily detached for servicing.

The chassis and panel layouts are clearly shown in the photographs. The power transformer is mounted in the lower right hand corner of the chassis. R6 is mounted on two of the transformer bolts, as is the two-prong plug assembly for the power-line connector. The relay is located between T1 and the panel. Immediately to the left of the power transformer the rectifier tube and the triple-unit electrolytic filter condenser can be seen. Next in line is the power tube, with the 6C6 farthest to the left. Between the two amplifier tube sockets, and near the back edge, is the socket for the seven-prong plug terminating the interstation wiring. The input and output transformers are located under the speaker.

Looking at the panel front, the power and talk-listen switches are located to the left, with the pilot light between. The volume control is positioned below the pilot light. The station selector is mounted directly below the speaker. Both of the latter two controls are positioned below the chassis top. The arrangement described gives a convenient layout with minimum lead lengths.

Ordinary bell wire was used for the interstation leads, the maximum voltage handled being 16 volts in the relay circuit. By shopping around, seven different insulation colors were obtained, providing color-coded leads. Some ingenuity will be required in getting the leads hidden in partitions, closets and the attic, but no special precautions need be observed except to keep the relay wires separated slightly from the others when this can be done easily. The use of bell wire keeps the cost of this part of the installation to a minimum. Connection blocks were inserted at strategic points as indicated in the wiring diagram. Transformer T4, which is a door chime transformer rated at 16 volts output, was installed in a closet, with a line cord switch as S8.

UNIVERSAL 1-KW AMPLIFIER

(Continued from page 57)

plished by means of the Variac or by means of a 200 watt, 110 volt lamp wired in series with the high-voltage transformer primary together with a switch for shorting out the lamp resistance for normal operation.

5. Apply the reduced plate and screen voltage and quickly tune the plate tank for minimum plate and screen current indication on the milliammeter. Adjust the coupling between the plate coil and the output link circuit until the combined plate and screen currents are about 200 to 250 milliamperes. Watch the color of the 4-125A plates at this current indication: they should be a dull orange in color and should be of equal brilliance. If the plate colors are not of equal brilliance, this indicates that one tube is either receiving inadequate excitation or is being loaded too heavily. It is sometimes necessary to move the center connection of a grid coil one way or the other before equal excitation to the two tubes is obtained.

6. If amplifier operation appears normal with excitation and reduced screen and plate voltages applied, momentarily remove the r.f. excitation from the input circuit and watch the plate and screen current milliammeter. If the fixed bias is sufficient, the plate and screen currents should drop to a very low value or zero. If the plate and screen current rises when the grid excitation is removed, insufficient fixed bias is being applied to the grids, the amplifier is oscillating, or there are parasitic oscillations taking place at some frequency far removed from the resonant frequency of the plate and grid tuned circuits. The grid current should indicate zero. If grid current is indicated when the r.f. excitation is removed, this is a sure sign of oscillation in the amplifier. If no grid current is indicated but the plate and screen currents rise when the r.f. excitation is removed, the trouble is almost certain to be insufficient fixed bias voltage.

7. Now, with the r.f. excitation removed, adjust the fixed bias voltage so that the total plate and screen currents are approximately 100 to 150 milliamperes. Rotate the grid and plate tank tuning condensers throughout their scales; at the same time watch the plate and screen current milliammeter. The current indication should remain constant. If it does not, parasitic or spurious oscillation may be taking place.

8. If there was a change in plate and screen current as discussed in step 7 above, adjust the trimmer condensers of the two parasitic traps under the chassis until the plate and screen currents remain constant at any setting of the plate and grid tank tuning condensers.

9. Connect the antenna to the output link, re-apply r.f. excitation to the grids and apply the full plate and screen voltage. Tune the grid and plate tank circuits as before and adjust the antenna loading for a combined plate and screen current of 300 to 400 milliamperes. Readjust the coupling between the r.f. excitation source and the amplifier grid circuit to give the proper grid current required for full power input operation.

10. If the operation of the amplifier now appears to be normal, the screen and control grid power dissipation should be checked before prolonged operation has taken place. The screen dissipation may be calculated by measuring the screen currents from the two tubes and the voltage applied to the screens. The power dissipation will be equal to E_sI_s, where E_s is the screen voltage and I_s is the total screen current. The total screen dissipation should not exceed the values given in the 4-125A operating conditions charts.

The grid dissipation is calculated from the following expression:

$$P_g = E_{cmp}I_c$$

Where P_g = Grid dissipation
E_{cmp} = Peak positive voltage
I_c = d.c. grid current

The grid dissipation for the 4-125As must not be allowed to exceed 3 watts per tube.

As the tables issued by the manufacturer show, the maximum plate dissipation per 4-125A tube for c.w. telegraph operation is 125 watts; for radio-telephone operation, the maximum plate dissipation per 4-125A tube is 85 watts. This means that at 100% modulation with a sustained sine wave, the plate dissipation will reach 125 watts per tube and, therefore, for radio-telephone operation, with normal efficiency, the plate power input will be limited to slightly over 700 watts per pair of 4-125As. On c.w. telegraph operation, however, the full input of 1,000 watts may be used.

Plate voltages up to 3000 may be

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COILS, CORES AND MAGNETS

(Continued from page 27)

must permit sufficient current to flow through the ballast for normal operation, make available enough starting voltage, yet limit the current to a safe value at all times.

Most inductances having d.c. in the windings have an air gap in the magnetic circuit. This is to increase the apparent permeability over that available without an air gap. The length of air gap which results in highest permeability and likewise highest inductance for the particular current conditions in the windings is called the *optimum air gap.*

Optimum air gap may be computed by proper application of the normal d.c. magnetization curve and the incremental permeability curve for a given steel and core. The procedure is rather lengthy and will not be presented here. The average experimenter would probably find it faster to use a test circuit and obtain apparent inductance, apparent permeability, and optimum air gap simultaneously.

Circuits suitable for measuring inductance, determining apparent permeability and optimum air gap, are shown in Figs. 4 and 5. The Fig. 4 circuit is suitable for low and zero direct current. D.c. saturation of the transformer core is eliminated with the Fig. 5 circuit but the circuit has the disadvantage of requiring two similar chokes.

In either circuit the d.c. is first adjusted to the normal working condition. R4 and R5, Fig. 5, must be so adjusted that no d.c. flows through R3. This can be determined by a d.c. v.t. voltmeter across R3. Sufficient a.c. voltage is applied to give the working values across

L1, as measured by an a.c. v.t. voltmeter. Connecting it across R3 will give the voltage drop due to the a.c. flowing through L1.

The optimum air gap may now be found by varying the gap length until the a.c. voltage across R3 reaches a minimum with the a.c. voltage and direct current across L1 held to the working values. For Fig. 5 the air gaps must be the same for L1 and L2 and both varied simultaneously.

INDUCTANCE FORMULAS

The *apparent inductance* of L1 in henries will be $L_a = .159 \times$

$$\frac{\sqrt{\dfrac{(R_3 E_L)^2}{E_R^2} - R_a^2}}{f}$$

where R3 = d.c. resistance of voltmeter shunt in ohms, E_L= a.c. volts across L1, E_R=a.c. volts across R3, f=a.c. test frequency, and R_a=apparent resistance of L1. (R_a consists of the d.c. resistance plus resistance effects due to core losses. The latter are very low in good-grade laminated cores.) Usually R_a is small compared to the inductive reactance of the coil and could be omitted, simplifying the formula to

$$L_a = \frac{.159\ R_3\ E_L}{f E_R}.$$

Because L1 and L2, Fig. 5, are in parallel, L_a must be multiplied by 2 to obtain the value for L1.

Knowing L_a, the apparent permeability can be found to be

$$\mu_a = \frac{10^8\, l\ L_a}{3.19\ N^2 A\ K_1}$$

where l = length of core in inches, A = area of core in square inches, N = number of turns in coil, and K_1 = stacking factor (usually about .9).

The a.c. flux density in lines per square inch will be

$$B_{ac} = \frac{10^8\ E_{rms}}{4.44 f N A K_1}$$

where E_{rms} = a.c. voltage across L1 and other symbols as before.

To simplify calculations for average cores an Iron-Core Inductance Design Chart has been constructed in Fig. 6. The symbols at the scale headings may be identified from the previous text. The multiplying scales X_1, X_2, X_3 are used to obtain readings.

The Inductance Design Chart is constructed to automatically allow a .9 lamination stacking factor. O_{dc} points, and the B_{ac} and TC_a turning curves were prepared from data on 29 gauge (.014-inch) steel laminations having properties similar to those on Curve 1, Fig. 1, which appeared last month. These properties were taken as an average. Some steels will give more inductance, others less. Now points and turning curves may be constructed for steels and cores with other characteristics. The balance of the chart would remain unchanged.

The previous B_{ac} formula may be used to assist in selecting one of the B_{ac} turning curves or O_{dc} points on the chart. Values of B_{ac} may be less than 65 for some interstage a.f. transformers and smoothing chokes while for some output transformers and swinging or input chokes it may go well beyond 3500. Turning curve TC_a is used to obtain air gap length for all values of B_{ac}.

USE OF THE CHART

Assume we have a core like Fig. 3 (last month's issue) to be used for a smoothing choke. The core is 1 inch wide and stacked 1 inch high using 29 gauge (.014-inch) steel laminations, making the area (A) = 1.0 square inch. The entire core has uniform cross-sectional area (each of the two outer legs have one-half the area of the center leg). The core length (average length around each window as indicated in Fig. 3) l_c = 6.0 inches. Window is ½ x 1½ inch. B_{ac} = 650 will be satisfactory and there will be 80 ma d.c. in the windings. The problem is to find the maximum inductance, L_m, in henries, and the optimum air gap, l_a, in inches.

The more turns the greater the inductance but wire size, allowable re-

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sistance and window area will limit the number. Wire size and coil dissipation watts may be computed as outlined for electromagnets. If the coil resistance is too great larger wire may be used.

A fairly reliable method is to select a wire, allowing 750 to 1250 circular mils per ampere. A wire table and a few computations will show that 3500 turns, No. 32 enamel wire, would go in the window and have a resistance of about 250 ohms.

This information may now be applied to the Inductance Design Chart, Fig. 6. The column headed "Order of Scales" indicates the function of certain groups of scales and under each function is given the order in which the scales are read at each setting of a straightedge. Mistakes will be prevented by writing down the reading for each scale.

Using the group of scales "FOR D.C." set a straightedge from 3500 (no. of turns) on N to 80 (no. of milliamperes) on M.A. and read 3.23 on X_1; From 3.23 on X_1, to 6 (lgth. of core, inches) on l_e and read 4.02 on X_2; Next from 6 (core lgth.) on l_e to 1 (core area, sq. in.) on A and read 8.78 on X_1; From the 8.78 on X_1 to 3500 (no. of turns) on N and read 7.38 on X_3; From 4.02 previously obtained on X_2 over the B_{ac} = 650 curve and read 222 on μ_a; From 222 on μ_a to 7.38 previously obtained on X_3 and read 13 on L_a, the apparent inductance in henries.

The optimum air gap may be found by using the "AIR GAP" group of scales. From 4.02 found above for X_2 over the point of the TC_c curve read 170 on μ_a; From 170 on μ_a to 6 (core lgth.) on l_e and read .0153 on l_a, the total length of the air gap, in inches. (See Fig. 3.)

Although not a part of the problem let us suppose there is no d.c. in the windings. What will be the inductance? For this we use the "NO D.C." group of scales. To proceed set a straightedge from 6 (lgth. of core) on l_s to 1 (area of core) on A and read 8.78 on X_1; From 8.78 on X_1 to 3500 (no. of turns) on N read 7.38 on X_2; From 7.38 on X_2 to $\frac{O_{dc}}{B_{ac}=65}$ point on μ_a and read 37 on L_a, the apparent inductance in henries. If B_{ac} is nearer 650 than 65, the L_a would be over 60 henries. No air gap would be used. Instead, the laminations would be interleaved as on any transformer.

TRANSFORMERS, SWINGING CHOKES

Audio frequency and output transformers are designed mainly on the basis of inductance of the primary winding, making the design problems similar to chokes except that secondary windings follow regular transformer procedure for impedance and turns ratios needed. Inductance values range from 2 to 50 henries and more, the higher inductance values giving better low frequency response, especially when used with tubes having high plate resistance.

Swinging chokes are often desirable when the load varies widely. The main difference between a swinging and smoothing choke is that the former, though designed for high d.c., has a shorter than optimum air gap. This shortened air gap lowers the inductance considerably at high d.c. loads and increases it at low d.c. loads when compared to a choke designed for high d.c. only.

The Fig. 6 chart is useful only for rough design of a swinging choke. Select the wire for the maximum d.c. ma and assume some value for turns to fit on the core. From the chart determine L_a at maximum d.c. and multiply the value found by 0.58 for the actual minimum swinging choke inductance. If this figure proves to be unsuitable try again using new values for turns or core.

After suitable values have been found for the maximum d.c. use all of them except that in place of the maximum d.c. ma substitute a value only 10 percent of the maximum d.c. ma and find the length of optimum air gap from the chart. Multiply the length as found by 2.6 to find the total air gap length to use for the swinging choke. Inductance ratio between maximum and 10 percent of maximum d.c. will be about 4 to 1. A shorter air gap would increase the ratio but would decrease the inductance at maximum d.c.

A handy reference chart of conversion factors and formulas (see page 27) shows some unusual variations. Unidentified symbols are explained in the text.

Acknowledgement is given Allegheny Ludlum Steel Corporation, United States Steel Corporation, and American Rolling Mill Company for information on electrical steels.

COMMUNICATIONS

A SUGGESTION AND COUNTER-SUGGESTION

Dear Editor:

I wish to make a suggestion that will make your magazine very popular, I think. I have had occasion to cut out many of your articles for future use and have been annoyed to find the article continued for one or two columns in the rear of the magazine.

To remedy this aggravation I suggest that each article be complete in itself and any leftover space be dedicated to advertising. Also to refrain as much as possible from putting two articles back to back.

HAROLD LEJUZ,
Long Island City, N. Y.

(Many suggestions as to better make-up have been made to RADIO-CRAFT. These range from a proposal to keep all the advertising in a separate section to the suggestion that *all* articles be backed up with solid advertising. Due to mechanical difficulties not less than the fact that no change would please everybody, it seems impossible to accede to any of these requests.

The satisfactory solution of the problem is to file the magazine *intact*. Then obtain a small card-file box and a pack of file-cards at the five-and-ten-cent store. Write down the names of interesting articles and file alphabetically under subjects. Thus it will be possible to turn up in a minute all the articles on a given subject, not only in RADIO-CRAFT but in other magazines, or even in books and publications not at the moment in your possession.—*Editor)*

WHAT IS A RADIO SERVICEMAN WORTH?

Dear Editor:

Have just read the August issue of RADIO-CRAFT. I have never written anything before but since reading, "Servicemen are honest," page 774, would like to say: Down here in Texas, a serviceman would starve to death at the prices Mr. Roth suggests. Just yesterday I had to pay 58c per box of 10 pilot lights. If I figure right this is 5.8c each, and 10c retail is not much profit if you have to take the chassis out of the cabinet, which you have to do in most midgets. He states you can replace a filter bank for $1.50. A three-section filter (when you can get them) costs you 94c here. And that "clean up and re-align" for 50c takes the cake! I charge $2.00 for b.c. sets and $3.00 for allwave, and don't think it's a penny too much. I for one haven't spent the money I have, as well as 18 years experience, to work for nothing. I think anytime a man has devoted his time and money for special training, equipment, etc., and can restore a radio to its original performance he should be paid a fair amount for his labor. My estimate on the job mentioned would—assuming the tubes to be valued as stated—be $9.25 plus $1.00 for pickup and delivery. I don't think this is an unfair price, and neither do I have any complaints on high prices.

Have read nearly every issue of RADIO-CRAFT for 15 years—a great magazine. I am not writing this to get under anybody's skin, but to quote conditions in our part of the country.

J. F. SNEED,
Waco, Texas

RADIO TERM ILLUSTRATED

Suggested by: Gus Britzman, Houston, Mo.
"Plate Supply"

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used for c.w. telegraphy; for telephony, however, plate voltages from 2200 to 2500 are recommended. Although the author has successfully operated the 4-125As with plate voltages as low as 1000 volts, such low-voltage operation is not recommended as the efficiency and power gain of these tubes drops off sharply as the voltage is decreased below 2500 volts.

Adequate cooling must be provided for the envelopes and seals of the 4-125As where medium or full input power is applied to the tubes. A small inexpensive blower or fan will usually be sufficient to move the two or three cubic feet of air per minute required for cooling of the stem structure. Better cooling efficiency can be obtained by directing the stream of air upward through the holes of the Johnson type 275 socket and the ceramic base of each tube.

List of Parts

CONDENSERS

1—Variable condenser, 2-gang, 99 μμf per section, 7000 volts peak, 0.175 inch spacing. Johnson Type 100DD70 or equivalent.
1—Variable condenser, 2-gang, 105 μμf per section, 2000 volts peak, 0.045 inch spacing. Johnson Type 100FD20 or equivalent.
1—Fixed condenser, mica, .005 μf, 1000 volts d.c.
1—Fixed condenser, mica, .001 μf, 12,500 volts d.c.
2—Fixed condensers, mica, 0.01 μf, 1000 volts d.c., or fixed mica condensers, .001 μf, 1000 volts d.c. See schematic.
2—Fixed condensers, paper, 0.02 μf, 600 volts d.c.
2—Adjustable trimmer condensers, mica (or air), 3 to 30 μμf.

COILS, ETC.

1—Complete set (80, 40, 20 and 10 meters) Barker and Williamson 75 watt plug-in, adjustable link type inductors. B. & W. Type JVL.
1—Complete set (80, 40, 20 and 10 meters) Barker and Williamson 1000 watt plug-in, swinging link type inductors. B. & W. Type HDVL.
1—Jack bar—swinging link assembly for above HDVL inductors.
1—R.f. choke, 2.5 mh., 500 ma.
2—Parasitic trap inductors—10 turns No. 14 enameled wire ¾-inch diameter, pulled out to form a coil 1½ inches long. Self-supporting.

RESISTORS

1—Fixed resistor, 35,000 ohms, adjustable, 100 watts.
1—Fixed resistor, 10,000 ohms, adjustable, 25 watts.

OTHER PARTS

1—Filament transformer, primary 110 v.a.c.; secondary 5 v.a.c., c.t. 13 amperes.
2—Closed-circuit jacks (for grid and plate milliammeter connections).
2—Eimac 4-125A beam tetrode transmitting tubes.
2—Special ceramic sockets for above tubes. Johnson Type 275.
1—Milliammeter, 3½-inch diameter, 0-50 ma. d.c.
1—High-voltage coupler, ceramic, ¼ to ¼-inch shaft.
1—Coupler, insulating type, ¼ to ¼-inch shaft.
1—Dial, direct drive, 0-100 clockwise over 180°, 4 inches diameter.
1—Dial, direct drive, 0-100 clockwise over 180°, 2¾ inches diameter.
1—Phone plug, bakelite shell.
1—Standard aluminum panel, 12¼x19x⅛ inches, black crackle finish. Parmetal Type 6681.
1—Standard steel chassis, 13x17x3 inches, cadmium plated finish. Parmetal Type C-4536.
2—Chassis mounting brackets. Parmetal SB-713.
1—Cabinet for complete transmitter. Parmetal Type "A" rack, 61¼x19-inch panel space, No. ER-225.

INDEX TO ADVERTISERS

BOOK REVIEWS

TEACH YOURSELF RADIO COMMUNICATION, by E. M. Reid. Published by David McKay Co. for English Universities Press, Ltd. Stiff cloth covers, 4½ x 7 inches, 176 pages plus index. Price $1.00.

This book is a simplified radio text prepared for the reader with little or no previous knowledge of the subject. Although written on an elementary plane, the author presupposes a knowledge of simple algebra for complete understanding of the material.

It is well illustrated with a number of diagrams and drawings which help to present radio theory in an interesting manner. It discusses, briefly, the fundamentals of practically all types of components and circuits that will be encountered in a radio receiver or transmitter.

The reader of American radio publications will notice, immediately, the slight difference in the style of drawings and in terminology that will mark the book as being "distinctly British," in its presentation. This difference in terminology is bound to be slightly confusing to the American radio beginner who is accustomed to calling a plate a plate, and the "electron bottle" a *tube*. Overlooking these difficulties in terminology, this book is a good text for the radio beginner.

RADAR — RADIOLOCATION SIMPLY EXPLAINED, by R. W. Hallows. Published by Chapman and Hall, of London, England. Soft cloth covers, 5 x 7½ inches, 136 pages plus 4-page index. Price, approximately $1.50.

The author of this text held the post of Chief Instructor in Fire Control (Radar) during the war and it was one of his duties to prepare easily understood material on radar for radar operator trainees. Clearly illustrated and concisely written, without resorting to mathematics or highly technical terms, this book is based on this basic training material that was prepared for radar operators.

The opening chapters deal briefly with the definition and applications of radar. An interesting analogy of radar, using sound echo ranging, helps the reader to understand just how radar works and what may be expected of it.

Chapters four through twelve are devoted entirely to fundamentals of radar. Chapters seven through ten are particularly interesting in the discussion of the cathode ray tube and how it may be employed as a stopwatch for measuring the time interval between the transmitted pulse and the arrival of the echo.

Chapters 11 and 12 are devoted to the antenna systems used in radar and are well illustrated with drawings showing the directional beam transmitting and receiving characteristics of these

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BOOK REVIEWS

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antennas. The two concluding chapters discuss briefly the war and probable peacetime applications of radar.

The book is illustrated with eight full-page photographic plates, mostly showing standard radar apparatus, as well as the excellent drawings already mentioned.

While definitely not an engineering treatise, this book will enable the reader to secure a good background on the operation of radar and its many applications in war and peace. Teachers will find the drawings especially useful in helping to get certain hard-to-explain ideas across to their students.

ELEMENTARY ENGINEERING ELECTRONICS, with Special Reference to Measurement and Control, by Andrew W. Kramer. Published by The Instruments Publishing Co., Inc. Stiff covers, 4½ x 8 inches, 340 pages. Price $2.00.

This book, of thirty-four chapters, begins with a simple explanation of the electron theory and the nature of electricity. With this as a background, the author explains the principles of operation of the various electron tubes in commercial use today.

The text of the book is confined to electronics in industry and does not touch the radio aspects of the field. As each tube type is discussed, the author provides interesting drawings to illustrate the operation of the basic circuit and to show how it may be applied to perform various control or metering operations.

The operational functions of vacuum tubes not fully understood by the average reader are clearly explained by mechanical analogies. This is particularly true of the operation of the thyratron whose operation is clarified by comparing the tube to a non-return fluid valve. Eleven step-by-step drawings are used to illustrate the operation of this tube.

This book will serve as a guide to students, engineers and maintenance men who desire an understanding of the many electronic principles and applications in industry today.—*R.F.S.*

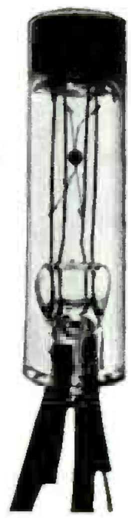
The Eye That Never Closes

You are looking at a thermistor — a speck of metallic oxide imbedded in a glass bead hardly larger than a pinhead and mounted in a vacuum. The thermistor was developed by Bell Telephone Laboratories to keep an eye on the amplification in long-distance telephone circuits.

When a thermistor is heated, its resistance to electric current changes rapidly. That is its secret. Connected in the output of repeater amplifiers, it heats up as power increases, cools as power decreases. This change in temperature alters the resistance, in turn alters the amplification, and so maintains the desired power level. Current through the wire at the left provides a little heat to compensate for local temperature changes.

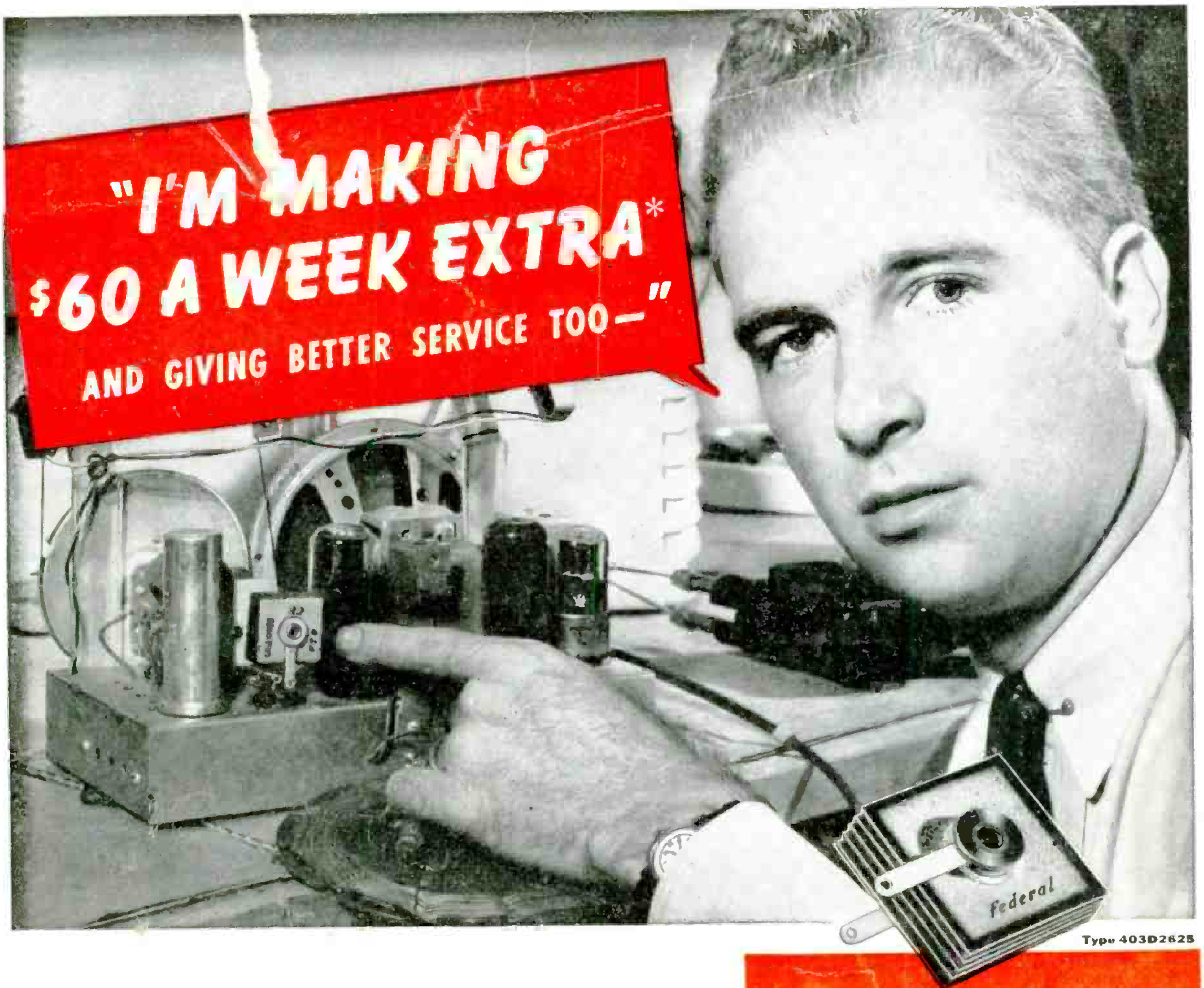
Wartime need brought a new use for this device which can detect temperature changes of one-millionth of a degree. Bell Laboratories scientists produced a thermistor which could "see" the warmth of a man's body a quarter of a mile away.

Thermistors are made by Western Electric Company, manufacturing branch of the Bell System. Fundamental work on this tiny device still continues as part of the Laboratories program to keep giving America the finest telephone service in the world.



BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE



Type 403D2625

by Installing Federal's Miniature Selenium Rectifier—in AC-DC home radio receivers to replace rectifier tubes

***HERE'S HOW YOU CAN DO THE SAME**

By installing Federal's Miniature Rectifier in place of a tube, you earn from $1 to $2 *extra* per set serviced. Ten sets a day gives you $60 a week (or more) added profit.

HERE'S A REAL OPPORTUNITY for the progressive service man — a chance to make extra money and do a better job. For Federal's new, miniature Selenium Rectifier is more than just a substitute for a tube. It's the modern way to give old sets new performance —gives them instant starting without warmup, makes them run cooler, last longer—replaces 29 different rectifier tube types.

Only $1\frac{1}{4}$ x $1\frac{5}{32}$ x $\frac{5}{8}$ inches, it fits anywhere, with just a few simple soldered connections and minimum circuit changes. Once installed, it's in for the life of the set. It withstands overloads from defective electrolytic condensers, and is practically unbreakable.

This miniature Selenium Rectifier gives the same performance that has made Federal "Center-Contact" Selenium Rectifiers the standard of the industry.

Replaces these 29 different rectifier tubes:

5T4	5Y3	6Y5	25Z6	50Y6
5U4	5Y4	6Z5	35W4	50Z7
5V4	5Z4	12Z5	35Z3	117Z3
5Z3	6X5	7Y4	35Z4	117Z6
5W4	0Z4	12Z3	35Z5	OY4
5X4	80	25Z5	35Z6	

FREE—eight page service bulletin telling how to install this rectifier in AC-DC radio sets. Miniature Selenium Rectifiers now available in standard packages of 12, with window poster and mailing pieces. Send check or money order for $12.00* for 12 rectifiers in display carton and complete sales accessories. Write to Dept. F863

*(excludes State and City use and sales taxes

Federal Telephone and Radio Corporation

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Export Distributors:—International Standard Electric Corp. 67 Broad St., N.Y.C.

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