HAM NEWS

MAY - JUNE, 1960

Also in this issue—

PI-NETWORK ANTENNA TUNER . . . page 3

PANEL VIEW of the one-kilowatt pi-network antenna tuner at W2FBS, constructed on an 8¾ x 19-inch aluminum relay rack panel. National type "O" dials are on C_1 and C_2.

MONITORING ADAPTER FOR OSCILLOSCOPES . . . page 6

MONITOR-ADAPTED 'SCOPE AT K2IOW, at right of desk, a Heath type 0-5 constructed from a kit. Space for the adapter components and additional panel controls can be found in most test type oscilloscopes.

NEW FAMILY of G-E full-wave rectifier types

NEW G-E RECTIFIER TUBES

NEW TUBE TECHNOLOGIES and materials have been combined by General Electric Receiving Tube engineers in three new rectifier tube types which are more efficient than previous rectifiers.

A new kind of fabricated 3-ply tubular cathode, which acts as its own heater and thus permits a 40 percent power saving, features the 3DG4 high vacuum rectifier now in production at General Electric.

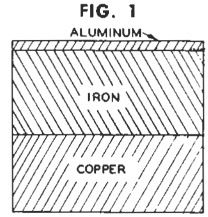
The total cathode and plate dissipation of the 3DG4 is 26 watts, compared to 42 watts for the 5U4-GB, a substantial saving in power loss and wasted heat.

This design offers several advantages. It permits use of a relatively large cathode emission surface, as opposed to the wire cathode of filamentary type rectifiers. Tube voltage drop is less than half that of older high vacuum rectifiers in similar service.

Elimination of a separate heater eliminates the possbility of heater-cathode failures through arc-over, breakdown or burn-out. Finally, the new large-surface cathodes in the 3DG4 provide exceptional mechanical strength. (continued on page 7)

CROSS SECTION Drawing of 3-ply plate material in G-E rectifier tubes. The bonded plate material employs copper both to conduct heat rapidly and to reflect heat where needed, aluminum to radiate heat, and iron to provide strength.

FIG. 1



—*Lighthouse Larry*

IRE SHOW STARS . . .

Many amateurs have been asking us, "What's new in ceramic tubes?" And our best answer has been to show them the ten types which were displayed at the 1960 IRE International Show and Convention in New York City last March.

Capable of operating at high temperatures, ceramic receiving tubes deliver the ultimate in high frequency performance in the small tube range without the use of blowers or other bulky, inefficient cooling systems.

As you can see from this picture, ceramic tubes vary in diameter from about half that of a pencil to a half dollar, depending on power output capabilities. Low noise figures feature their UHF performance. The tubes are easy to mount, rugged, and provide flexibility in circuit design. General Electric's line of registered types includes:

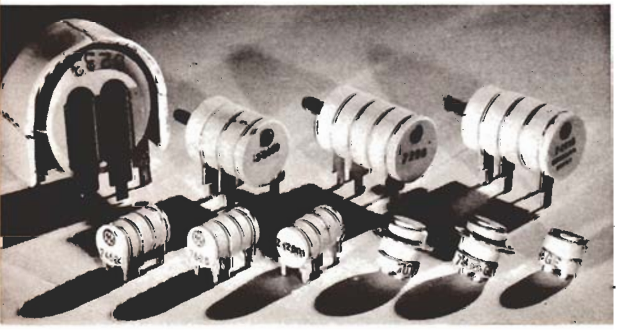
7077 — low-noise high gain triode for RF amplification.
7266 — high impedance, high frequency diode detector.
7296 — VHF power amplifier triode.
7462 — low noise, high frequency amplifier.
7486 — high frequency multiplier and oscillator.
7625 — low-microphonic high impedance, high voltage gain triode amplifier.

Development models are:

— Broad-band, low-noise triode amplifier.
— High peak inverse voltage medium power diode rectifier.
— Low Mu linear triode power amplifier.
— Small high frequency oscillator and multiplier triode.

Of particular importance is the fact that ceramic receiving tubes are relatively immune to nuclear radiation.

Increasing acceptance of ceramic receiving tubes is reflected in General Electric's Receiving Tube Department at Owensboro, Ky., expanding its line of these devices.



COMING NEXT ISSUE . . .

. . . information on high power, high-voltage supplies for mobile operation, plus a construction article on crystal controlled mobile converters. Also, we'll tell you about new, high-gain pentode receiving tubes. Ask for this issue from your nearby G-E Tube distributor. He'll have it about July 15.

NEW PUBLICATIONS . . .

We're planning three new projects at *G-E HAM NEWS* and want our readers to know about them, since we have had many inquiries about the first two. Details on each project follow.

1. THIRD BOUND VOLUME:
Yes, we're planning another bound volume of *G-E HAM NEWS,* to be made available in December, 1960 (in answer to a multitude of requests).

This book will contain all thirty isues of *G-E HAM NEWS* published from January-February, 1956 (Vol. 11, No. 1), to November-December, 1960 (Vol. 15, No. 6).

For those who are not acquainted with our bound volumes, this will be the third such book. The first and second bound volumes (no longer available, and now collector's items, incidentally) contained all issues published in 1946 through 1950, and 1950 through 1955, respectively.

The third bound volume will be rugged hard bound with the cover in grey, orange and black. The book will contain about 260 pages and include a complete cross index of all material contained therein. The cost will be $2.50, postpaid.

2. NEW SIDEBAND BOOK:
Since our supply of the *SSB PACKAGE* of *G-E HAM NEWS* has run out, we're considering compiling all the information we have ever published on sideband techniques — both single and double — plus related subjects, into a bound book.

This proposed book would contain about 150 pages and be the same over-all size as the present *G-E HAM NEWS.* We're aiming at a selling price of $1.00 per copy, postpaid. The book will be announced early next fall.

3. KING-SIZE G-E *HAM NEWS?*
In our continuous program to improve *G-E HAM NEWS,* we've been studying a larger page size — 8½ x 11 inches — as compared to the present 6½ x 9¼-inch page size. The larger page size would provide 60 percent more usable editorial space in each regular 8-page issue.

If we change the size, it will start with the January-February, 1961 issue. It also will be punched for insertion in a standard 3-ring binder, thus providing a convenient means for keeping your back issues in good condition.

PI-NETWORK ANTENNA TUNER IDEAS

By S. E. Johnson, W2FBS*

***END-FEEDING LONG-WIRE ANTENNAS** can be simplified with this pi-network antenna tuner which will match a low-impedance transmitter output to a 100-2,400-ohm antenna impedance.*

A LOW-PASS FILTER is usually required at the output of a transmitter for good suppression of television-interfering harmonics. If an end-fed antenna is connected directly to the final amplifier plate tank circuit, there is no convenient way to introduce the low-pass filter between the transmitter and antenna.

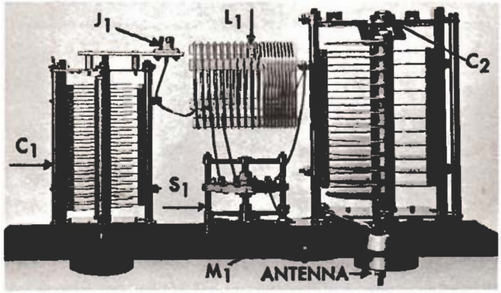
Since a long-wire antenna will accept and radiate any and all signals that the transmitter produces, the low-pass filter is essential. It should be located as close as possible to the transmitter, and a coaxial cable run to a separate antenna impedance matching network, located close to the antenna.

During the 1930's the pi network was a very popular antenna matching device. Double pi networks were often used to match transmitters to balanced open-wire feedlines. However, the pi network was "discovered" as a plate tank circuit about 15 years ago and it fell into oblivion as an antenna matching device. This was largely due to the popularity

(continued on page 4)

TABLE I — PARTS LIST, PI-NETWORK TUNER

- C_1.....30-350-mmf variable, air gap 0.03 inches per 1,000 plate volts on final (For up to 1,500 volts, use Cardwell PL-8004 or Johnson 350E20, Cat. No. 154-2; for 1,500 to 3,000 volts, use Cardwell PL-8044 or Johnson 350E30, Cat. No. 154-10).
- C_2.....20-200-mmf variable, air gap 0.07 inches per 1,000 plate volts on final (For up to 1,500 volts, use Cardwell PL-8050 or Johnson 250E45, Cat. No. 154-16; for 1,500 to 3,000 volts, use Cardwell TC-200-US, or Johnson 250D70, Cat. No. 153-13).
- J_1......chassis type coaxial cable jack (50-239 type).
- L_1......15 microhenries, 20 turns, No. 10 tinned wire, 3 inches in diameter, 3¾ inches long; 10 turns wound 4 turns per inch (2½ inches long) and 10 turns wound 8 turns per inch (1¼ inches long) (air-dux No. 2408D4 dual pitch inductor).
- L_2......Same coil as L_1 tapped every second turn.
- M_1....0-4-ampere thermocouple type r.f. ammeter (G.E. type DW-52, or equivalent).
- S_1......Fig. 1: 3 position, 1 section heavy duty ceramic insulated tap switch (from BC-375 transmitter).
  Fig. 2: 11-position, 1 section 10-ampere power tap switch ceramic insulation (Ohmite Model 111, 11 taps).



TOP VIEW of the one-kilowatt pi-network antenna at W2FBS. The coil taps shown at 3 and 5 turns from the C_1 end of L_1 are for a 243-foot long wire antenna. The same parts layout should be followed for the tuner in Fig. 2. A tuner with smaller components for 100-watt class transmitters can be housed in a 5 x 6 x 9-inch box, or on a rack panel 3½ inches high.

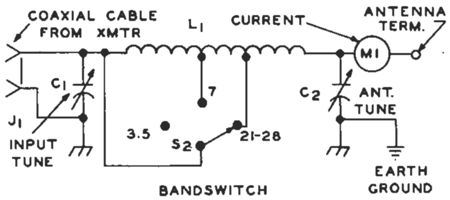


FIG. 1. SCHEMATIC DIAGRAM of the pi-network antenna tuner model shown in the photos.

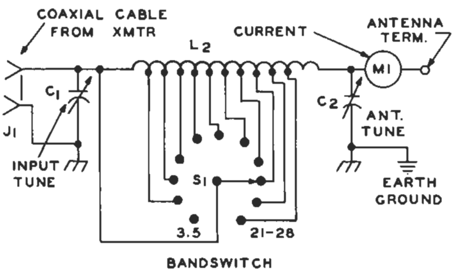
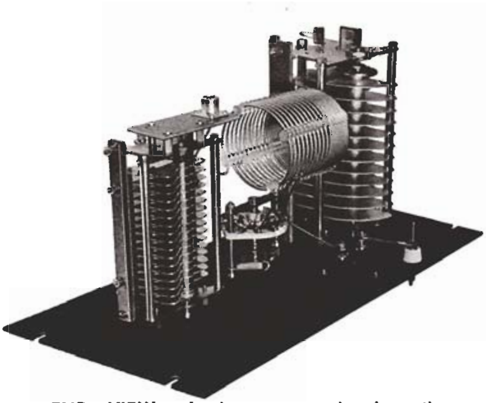


FIG. 2. DIAGRAM of a tuner with additional taps on the coil to obtain a precise impedance match. A 15-microhenry rotary inductor (Johnson 229-202, or equivalent) can replace L_1 and S_1.

*W2FBS, a mechanical engineer by profession, is Manager — Pump and Valve Engineering, in the Machinery Apparatus Operation of General Electric's Turbine Division in Schenectady, N. Y.

His previous contributions to **G-E HAM NEWS** have been the "SOLID HIGH-C VFO" in the July-August, 1959 issue, and as consultant for the Special DX LOG Issues of **G-E HAM NEWS** (the latest DX LOG was published in July-August, 1958). The latter is a by-product of Sam's ardent DX chasing; his present DXCC country total is just over 250.



END VIEW of the tuner, showing the aluminum plate on which the coaxial cable input connector, J_1, fastened to C_1.

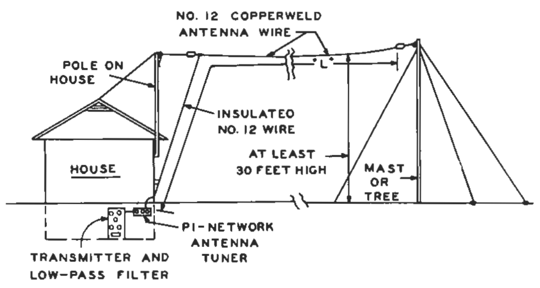


FIG. 3. END-FED ANTENNA installation at W2FBS. For best results the horizontal portion should be at least 30 feet above ground, and preferably as high as possible. A short, heavy lead should be run from the antenna tuner to the nearest good ground, the same ground as used for the power system.

TABLE II — END-FED ANTENNA LENGTHS

Over-all Length "L," Including Lead-in (Feet)	Number of Quarter Wavelengths at					
	3.5 MC.	4.0 MC.	7.0 MC.	14 MC.	21 MC.	28 MC.
105	1.5	1.71	3	6	9	12
173	2.5	2.86	5	10	15	20
243	3.5	4.0	7	14	21	28
313	4.5	5.15	9	18	27	36
383	5.5	6.29	11	22	33	44

(continued from page 3)

of coaxial feedlines and the impedance matching properties of the tank circuit itself. By turning a pi network around, it can match a low-impedance coaxial cable to a high-impedance end-fed antenna.

At W2FBS, a pi-network tuner was constructed to resonate a long wire antenna on three bands, 3.5, 7 and 21 megacycles. The schematic diagram is shown in Fig 1. Total inductance of the coil, L_1, for the 3.5-megacycle band, and the tap positions for 7 and 21-megacycle operation, were determined by experiment. A 0-4-ampere r.f. ammeter was installed to indicate maximum antenna current.

More taps can be added to L_1, as shown in the diagram of Fig. 2, to provide greater flexibility in matching. An 11-position power type tap switch will withstand the r.f. voltages present when insulated from the tuner panel. Taps on every other coil turn.

A RACK PANEL was used to support all components in the pi-network tuner at W2FBS, shown in the photos. Any make of variable capacitor having the proper capacitance and plate spacing should be suitable for C_1 and C_2. The coaxial cable connector was mounted on an aluminum bracket fastened to C_1. The coil was supported between the capacitors on its leads (No. 10 wire). Leads for the coil taps and ammeter connections were made from No. 12 tinned solid wire. The parts layout for this tuner is shown in Fig. 3.

A 15-microhenry rotary inductor can be substituted for L_1 and S_1. Its current rating should be at least 5 amperes for a kilowatt transmitter. For 100-watt class transmitters, use smaller tuning capacitors and inductance, as suggested in TABLE I.

When installing the pi-network antenna tuner, be sure to connect the panel to an earth ground with a short, direct lead. Preferably, the tuner should be located close to the point at which the end-fed antenna lead-in enters the station. A standing wave ratio indicator in the coaxial cable between the transmitter and tuner is handy for initially determining the correct settings for C_1, C_2 and S_1 for each of the bands to be covered.

The end-fed antenna installation at W2FBS is depicted in Fig. 3. Note that the total length of wire in the antenna is measured from the connection to the antenna tuner. If the ground lead is more than a few feet long, it should be included in the over-all length.

By selecting an antenna length that is an odd number of quarter wavelengths long on the lower frequency amateur bands, the feed

IMPROVED CARBON MICROPHONE CIRCUITRY

By D. T. Geiser, WA2ANU*

"SNEAK" CIRCUITS in carbon microphones can disrupt control circuits, or even run down batteries. Here's WA2ANU's answer.

THE INTERNAL CIRCUITRY of the TS-13 handset can cause difficulty when the microphone plug is inserted into circuitry designed for the T-17 microphone. The differences in internal wiring are shown in Fig. 1. (It is not known whether *all* have these circuits, but they have been found in the T-17D and TS-13E. Several other types of carbon microphones also have similar internal circuitry.

The switching circuit has separate leads in the T-17 microphone cable, but the TS-13 has a common lead, connected to the tip of the plug, for the "cold" side of the microphone and the connection for the control circuit switch. Thus without the switch pressed, power can travel from the microphone circuit into the control circuit, or vice versa.

THIS "SNEAK" CIRCUIT can "hold-in" control circuit relays or discharge microphone batteries, to name only two undesirable effects. If both microphone and control circuit supplies are direct current (a good idea), a rectifier can be used to open this sneak circuit. A diode with low leakage, such as the G. E. 1N91, can be connected in the forward direction for the lower voltage supply, both supplies having the same polarity with respect to ground. Fig. 2 shows the 1N91 in the microphone lead; if the control voltage is lower than that on the microphone, the diode should be in series with the relay coil. Of course, if the two voltages are equal, no diode is needed.

If you have noticed relays mysteriously holding your equipment, try adding the 1N91 diode to eliminate "sneak" circuits.

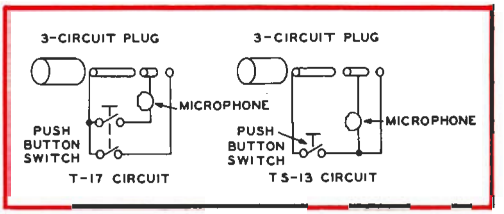


FIG. 1. COMPARISON of circuitry found in some T-17, TS-13 and other carbon microphones with push-to-talk switch buttons. Note that the T-17 has a fourth lead for the control circuit which becomes common with the microphone circuit at the 3-way plug.

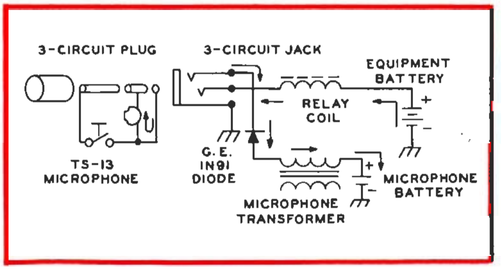


FIG. 2. A G. E. 1N91 junction diode blocks the circuit by which reverse current could otherwise flow when the push-button switch is open (current path is traced by arrows). Power supply polarities should be the same. The diode should be connected in the forward direction of the lower voltage supply.

*WA2ANU is a components engineer with General Electric's Light Military Electronics Department, Utica, N. Y.

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point will be at a current node and impedance matching problems are minimized. Suggested over-all lengths are shown in TABLE II. At W2FBS, a wire 243 feet long was strung up. This length is slightly less than one wavelength long on the 3.5-megacycle band, so that the feedpoint is between a voltage and a current maximum. At 14, 21 and 28 megacycles, the antenna has enough quarter-wavelengths so that other effects are more important in determining the feedpoint impedance at the tuner.

A 313-foot-long wire antenna will have a current maximum at the feed point on both 4 megacycles, and 7 megacycles. To calculate the over-all length of an even longer odd-quarter wavelength end-fed antenna, add 70 feet for each *two* additional quarter wavelengths at 7 megacycles. Of course, the pi-network antenna will match a transmitter into almost any odd length of wire, in addition to the standard resonant lengths. However, at or near a current node, the matching will be much easier, and there will be less r.f. energy radiated at the antenna tuner.

INITIAL TUNEUP for each amateur band is simply a matter of determining the capacitances and inductance required for a combination of the desired DC plate current on the transmitter's final amplifier, lowest standing wave ratio in the coaxial cable from the transmitter, and the highest antenna current reading on the r.f. ammeter.

First set C_1 at maximum capacitance, then try L_1 at different taps, retuning C_2 as needed, for maximum output with a minimum standing wave ratio. If the transmitter cannot be loaded heavily enough, set C_1 at a lower capacitance and again adjust L_1 and C_2. When the correct settings have been established for each band, mark the settings on the dials or a calibration chart for instant tuneups thereafter.

MONITORING ADAPTER FOR OSCILLOSCOPES

By Robert (Bob) A. Hall, K2IOW*

THIS BUILT-IN ADAPTER provides both r.f. and audio signals for a test oscilloscope, permitting visual monitoring of the modulation on amateur transmitters.

TEST OSCILLOSCOPES are coming into wide use among radio amateurs, thanks to the low cost 'scope kits on the market. In addition, many amateur radio clubs now have 'scopes available for loan to members for checking their equipment.

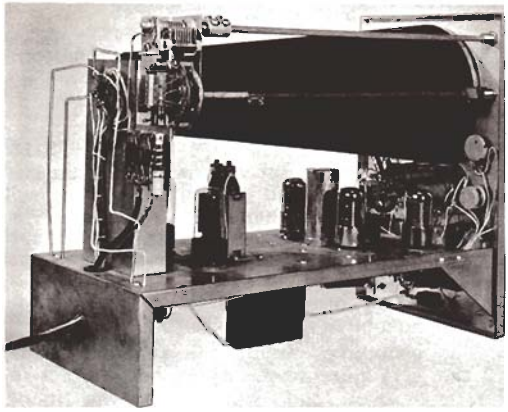
The utility of these 'scopes is greatly increased by building in a bandswitching tuned circuit, connected to the cathode ray tube's vertical deflection plates. But this change alone does not provide a sample of the audio output signal from the transmitter, necessary for forming the *trapezoidal* type test pattern on the oscilloscope screen.

The addition of a simple diode demodulator circuit and r.f. filter to the tuned circuit provides this audio signal, avoiding the complication of having to tap it from the transmitter's audio section. The audio signal from the diode is then applied to the horizontal amplifier in the oscilloscope.

The complete circuit is shown in the schematic diagram, Fig. 1. Connection to the

(continued on page 7)

*K2IOW is a time-standards engineer with General Electric's Methods and Time Standards Service operation in Schenectady, N. Y. Bob will be remembered by many readers for his previous articles in G-E HAM NEWS: COMPACT TRIODE KILOWATT, modern construction of a final amplifier with paralleled GL-810's, September-October, 1959 (Vol. 14, No. 5) issue; and, BANDSWITCHING HIGH-C VFO in the March-April, 1959 issue, Vol. 14, No. 2). Copies of these issues are available upon request to the G-E HAM NEWS office.



SIDE VIEW of the 'scope, with the adapter on the vertical support for the cathode ray tube socket.

TABLE I — PARTS LIST

C_1	8-100-mmf variable (Hammarlund MC-100S)
J_1	chassis type coaxial cable connector; phono type jack is suitable.
L_1	21 uh, 36 turns, No. 20 tinned wire, 1 inch in diameter, 1 1/8 inches long, 32 turns per inch, tapped at 18 turns (7 Mc.), 24 turns (14 Mc.), and 32 turns (21 and 28 Mc.) from grounded end No. 3016 Miniductor, or air-dux No. 832 coil stock).
L_2	6-turn link coil of same coil stock at grounded end of L_1.
P_1	male type coaxial cable plug; phono type plug is suitable.
RFC_1	2.5-mh pi-wound r.f. choke (National R-100, or equivalent).
S_1	1 pole, 4 positian, single section rotary tap switch.
S_2	1 pole, 2 position toggle or selector switch.
T	Amphenol type 83-1T coaxial Tee connectar.

CLOSEUP VIEW of the bandswitching tuned circuit and demodulator an insulated terminal board.

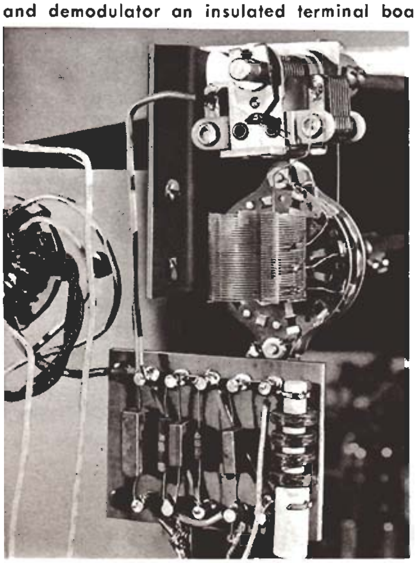
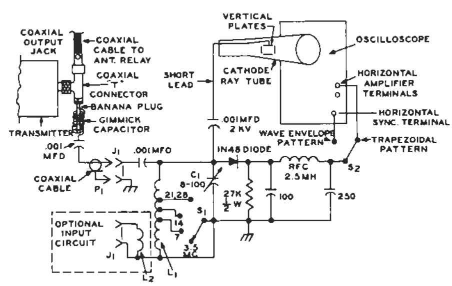


FIG. 1. SCHEMATIC DIAGRAM of the 'scope adapter. All components to the right of J_1 shauld be installed inside the 'scope cabinet. The optional link coupling circuit, L_2, is recommended where mare than 10 feet of coaxial cable is required between the transmitter and oscilloscope. The "gimmick" capacitor should then be replaced with a 10-mmf mica capacitor. All capacitances are in mmf, mica, unless otherwise specified.



(continued from page 6)

transmitter r.f. signal is made by adding a "T" type coaxial cable connector (Amphenol 83-1T) between the r.f. output jack and the coaxial cable running to the antenna tuner or antenna changeover relay. A banana plug is inserted into one side of the "T," with an inch or two of insulated wire connected to it. Another insulated wire is then wrapped around it to form a small "gimmick" 1 to 4-mmf coupling capacitance or, a small variable capacitor will permit precise adjustment of coupling.

The tuned circuit consists simply of a 100-mmf variable capacitor and a tapped coil, permitting coverage of from 3.5 to 30 megacycles. The demodulated audio output may be applied either to the 'scope's *horizontal amplifier;* or, to the *horizontal sync* terminal. The latter connection provides synchronizing voltage for the horizontal sweep circuit in the 'scope when the wave-envelope type pattern is employed to check the transmitter. A selector switch (S_2) is handy here, but a lead which can be connected to either terminal will suffice.

CONSTRUCTION of the adapter will depend upon the physical layout of the 'scope to which it is being added. The installation shown in the photos used a simple aluminum angle bracket to support the tuning capacitor and bandswitch. All the demodulator components were mounted on a small terminal board. Insulated extension shafts were run from the capacitor and switch (S_1) to panel control knobs.

The connection from the tuned circuit to the vertical 'scope plate should be as short as practical; that is why the tuned circuit was mounted close to the base of the cathode ray tube. The .001-mfd coupling capacitor should be rated for twice the DC high voltage on the tube.

The coupling capacitor should be adjusted to provide full vertical deflection on the oscilloscope screen with the tuned circuit resonated at the lowest transmitter operating frequency. Then, the capacitor should be detuned for correct pattern height on the higher frequency amateur bands.

Examples of the correct and incorrect oscilloscope waveforms for amplitude-modulated, single sideband and double sideband transmitters can be found in the amateur radio handbooks. The subject is too comprehensive to be reviewed here.

This simple 'scope adapter has seen service at K2IOW for about two years and has been instrumental in insuring that *clean* amplitude-modulated and sideband signals emanate from our COMPACT TRIODE KILOWATT.

NEW G-E RECTIFIER TUBES

(continued from page 1)

Cathode heating time of all three types, the 3DG4, 5AR4 and 6CA4, approximates that of other cathode type tubes. Thus, the power supply voltage surge which usually occurs with fast-heating rectifiers, before slow-heating tubes draw plate and screen currents, does not happen. Filter and bypass capacitor breakdowns from this cause are minimized.

In addition to the 3-ply cathode material, new 3-ply plates have been incorporated into the 3DG4, 5AR4, and 6CA4. The bonded plate material, shown in Fig. 1, spreads heat evenly, uses it where it is needed, and dissipates heat efficiently where it is not needed.

Typical operating conditions for these new rectifiers are given in TABLE I. For performance comparison, ratings of the 5U4-GB also have been listed. Complete technical data for all types is available upon request to the *G-E HAM NEWS* office.

Utilize these efficient new rectifier tubes in your new home-constructed amateur radio equipment. Try the 5AR4 as a plug-in replacement for older rectifier types having similar base connections for improved performance.

TABLE I — CHARACTERISTICS AND OPERATION

FULL WAVE RECTIFIERS WITH CAPACITOR INPUT FILTER

TUBE TYPE	3DG4	5AR4	6CA4	5U4-GB	
Cathode	Coated Directly Heated	Coated Unipotential	Coated Unipotential	Coated Filament	
Heater Voltage, AC or DC	3.3 ± 10%	5.0 ± 10%	6.3 ± 10%	5.0	Volts
Heater Current	3.8	1.9	1.0	3.0	Amperes
AC Plate-Supply Voltage per Plate, RMS	275	550	350	450	Volts
Filter Input Capacitance	40	40	50	40	Microfarads
DC Output Current	350	160	150	275	Milliamperes
DC Output Voltage at Filter Input	300	620	347	460	Volts
Tube Voltage Drop	25	17	20	50	Volts
at Current per Plate	@350	@225	@150	@275	Milliamperes

13 WPM FROM ~~DASH~~ START TO DASH

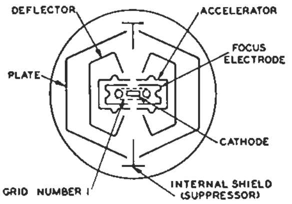
6AR8 SHEET BEAM TUBE

The General Electric 6AR8 is a miniature double-plate sheet-beam tube which incorporates a pair of balanced deflectors to direct an electron beam to either of the two plates, and a control grid to vary the intensity of this planar beam, or "sheet." The 6AR8 is especially suited for amateur radio applications in balanced modulator, frequency converter and product detector circuits. It also has a variety of switching and gating applications.

A cross-section diagram of the 6AR8's unique construction is shown at the right. As the electron beam leaves the cathode, it is acted on by the control grid and focus electrodes. Between the accelerators and the plates, the electron beam passed between the deflector electrodes. Depending on the voltages applied to the deflectors, the beam is directed entirely to one or the other plates, or proportioned between them. The internal shields, located between the two plates, acts to suppress the interchange of secondary-emission electrons between the plates.

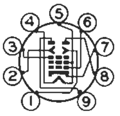
In balanced modulator operation, for instance, one input signal is applied to the control grid, and the other to the accelerators with a push-pull circuit. The output signals are then present at the plates, and the proper signal frequency is selected with a push-pull tuned circuit.

Try the *G-E* 6AR8 in your new home-built equipment. Complete technical information is available on request to the *G-E HAM NEWS* office.



CROSS-SECTION SCHEMATIC DIAGRAM OF THE 6AR8

BASING DIAGRAM



RETMA 9DP
BOTTOM VIEW

TERMINAL CONNECTIONS

Pin 1—Deflector Number 2
Pin 2—Deflector Number 1
Pin 3—Accelerator
Pin 4—Heater
Pin 5—Heater, Internal Shield, and Focus Electrodes†
Pin 6—Grid Number 1 (Control Grid)
Pin 7—Cathode
Pin 8—Plate Number 2
Pin 9—Plate Number 1

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