Our DOUBLE SIDEBAND JUNIOR article a year ago sparked much interest in a more powerful double sideband transmitter with bandswitching. Now several radio amateurs at General Electric have combined their ideas in this transmitter with 200-watt peak power input capability from a pair of 6146 beam pentodes in the output stage. The complete circuit, and constructional details on the plug-in r.f. unit, is in this issue. Part II, in the July-August, 1959 issue, describes the main chassis containing audio system, power supplies and control circuits.

—Lighthouse Larry
TALK ABOUT DX RECORDS—our tiny 7077 minicircuit ceramic receiving tube has established a "universe record" for long-dist
ance communications—407,000 miles!

And this was accomplished with milliwatts—not kilowatts—of r.f. power at 900.5 megacycles. A 7077 delivered 180 to 230
milliwatts as a Class B final amplifier in the transmitter of the Pioneer IV satellite; now hurtling in orbit about the sun. Strong signals
from the transmitter were recorded for more than three decades.

The 10- to 15-milliwatt transistorized ex-
citer was thus amplified nearly 20-fold by the
7077, producing sufficient power to permit use
of 960 megacycles for tracking and telem-
etering. This frequency is much less subject to
bending and reflection by the Earth's ion-
ized layers than 108 megacycles.

An exact duplicate of the record-breaking
transmitter was displayed in General Elec-
tric's receiving tube exhibit at the 1958 IRE
convention and show in New York City.

The 7077, first in a family of G.E. ceramic
receiving tubes, also is an excellent r.f. am-
pifier tube for the VHF and UHF amateur
bands. See the January-February, 1959 is-
sue of G.E. Ham News for details on r.f.
amplifiers for 144 and 432 megacycles.

From one of our GADGET RACK* series
authors comes the hint that a two- or three-foot
extension cord is very handy for testing acces-
sory units before installing them in the rack.
Simply cut 11 lengths of the same type of wire shown for the bus-bar interconnection
system in the schematic diagram, solder them
into an 11-pin male octal plug (Amphenol
86-PF11), and add an 11-pin female socket
(Amphenol 78-PF11) on the other end. In
fact, it's almost a necessity for aligning our
CONEL MONITOR receivers. If you're build-
ing a GADGET RACK, be sure and use the extension cord too.

CONEL and monitoring
extension cord too.

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FOR YOUR ELECTRONICS' BOOKSHELF...

Here's the latest in reference and instruc-
tional publications—packed with useful in-
formation for radio amateurs—which should
be in your bookcase and the reference library
at your local radio club.

THE RADIO AMATEUR'S HANDBOOK—The
36th edition of this volume—now well on its
way toward a total of four million copies in
thirty-years—on the tradition of being
the "amateur's Bible." All chapters in the book
have been updated to include the latest in de-
sign and constructional techniques. Published
by the American Radio Relay League, its
reputation speaks for itself.

ALSO FROM A.R.L.—A second printing of
the 8th edition of their Antenna Book includes
the latest in mobile and beam antenna systems,
in addition to comprehensive background in-
formation on antennas and transmission lines.

RADIO HANDBOOK—A completely new 15th
dition of this renown handbook by William
L. Orr, W6BAI, contains, in 800 pages, un-
doubtedly the most complete collection of
constructional projects ever offered the radio
amateur. This, of course, is in addition to ch-
ters of technical background, excellent
ircuit design information on both basic
nd the latest techniques. And if you don't see
exactly the gear you wish to build in the
15th edition, try looking in Bill's 14th edi-
tion. It's still available and has enough build-
it-yourself data to last a lifetime.

FOR SIDEBANDERS—The New Sideband
Handbook, by Don Stoner, W2TSN, contains
a wealth of information on both home con-
structed and commercial sideband equipment
for radio amateurs. Much of the special cir-
cuitry from the commercial rigs is explained
in detail, making it easy to incorporate these
ideas into your own sideband rig. In short, it
covers sideband from double down to single
and back again.

A PAIR OF HANDBOOKS—Especially writ-
ten for the newcomers to amateur radio and
the amateur service in the amateur radio
newspaper circuit, these books are un-
ique in that they are a series of 12 in-
clusive guides to their titular subjects. The
authors, Julius Benben, W7FJH, has described
home-built receivers and transmitters, and
some popular commercial amateur gear in the
first book. The second volume contains com-
plete instructions for learning the code and
studying for the Novice and General Class
radio licenses. Twenty-seven pages of excerpts
from the U.S. Code, 1958, (pages 1-44) are
also included, along with the latest informa-
tion on radio regulations. Both books are
published by the John F. Rider Publishers, Inc.
and should be in the library of every amateur
of the hobby. You can obtain the books either
through book stores and many distributors
of electronic components, including our G-E Tube distributors.

—Lighthorne Larry.
DOUBLE SIDEBANDER

Part I

THIS DOUBLE SIDEBAND Transmitter is packed
with ingenious circuits and construction features.
By Frank C. Bamboo

THE DOUBLE SIDEBANDER was designed
specifically for this mode of transmission;
and, in fact, was a prototype for military
double sideband and synchronous communi-
cations equipment. The frequency coverage
is continuous from 2 to 30 megacycles in four
bands. It has a peak power output, with
sine-wave modulation, of 150 and 120 watts
at 2 and 30 megacycles, respectively.

The R.F. SECTION of the transmitter—a
separately shielded and filtered unit—employs
an oscillator-driver-final circuit arrange-
ment as shown in the schematic diagram, FIG. 1. All transmitter stages are provided
with protective bias to prevent damage to
the tubes in the absence of excitation. In the
oscillator and driver stages cathode self-
bias give the necessary protection. The final
stage protective circuit removes its high
voltage if the r.f. drive fails.

Switch S1a, in the grid circuit of the 6A5S
oscillator stage provides selection of one of
the four crystals or the V.F.O. input as the
frequency source. With S1a in the V.F.O.
position the 6A5S is employed as a Class A
amplifier. An input from a V.F.O. of 0.5 to
1 volt r.m.s. will excite the driver stage.

All frequency multiplying is accomplished
in the oscillator and the 6CL6 driver always
operates as a straight amplifier. Since the
pi network in the 6146 balanced modulator
plate acts as a low-pass filter, sub-harmonics
of the carrier frequency may appear in the
transmitter output if the driver stage is
operated as a frequency multiplier.

Careful circuit layout and complete r.f.
insulation stabilize the driver stage. The
15,000-ohm, 4-watt potentiometer (“PA GRID
DRIVE”) adjusts the 6CL6 screen voltage and,
in turn, its r.f. power output.

The 6146 balanced modulator stage has
the usual push-pull control grids, push-pull
screen grids and paralleled plates described
in usual previous double sideband trans-
mitter articles. The pi-network plate circuit
is designed for a 50-ohm output, but will
lead to impedances up to 300 ohms.

The MODULATOR SECTION is designed for
unlimited carrier output, high quality micro-
phone (crystal, ceramic, or dynamic). Low
impedance microphones will require a match-
ing transformer. The preamplifier stage (V1)
has a push-to-talk feature that cuts off the
second section until closing the microphone
switch greatly reduces the cathode bias. A
twin diode tube (V4) serves as an audio peak
clipper. The next tube (V5) is a matching
device for the maximally-flat (Butterworth)
L/C 5,000-cycle low-pass filter.

A 400-cycle phase-shift R/C sine wave
oscillator (V6) and a split-load phase
audio phase inverter (V7') precede the
push-pull driver (V11). The modulator tube
(V12) provides about 300 volts peak on each
screen grid of the 6146 balanced modulator
stage. About 8 decibels of inverse feedback
in the driver and modulator stages improves
balance and linearity in the 6146 stage.

THE TRANSMITTER CABINET with the top lid open,
showing the shielded r.f. compartment in the front,
sound section in the middle and power supplied at
the rear. Note the method of storing spare plug in
on an aluminum plate, on which 4 and 2µ grids
have been mounted. Coils are changed in the exciter simply by removing four self-tapping screws which hold the
aluminum plate in place.

FRONT VIEW OF THE TRANSMITTER with cabinet
and panel removed. The separate chassis containing the r.f.
and metering section plugs into the main chassis, con-
taining the remaining circuits.

(continued on page 4)

1See G.E. THAMES NEWS, March—April, 1939, for a bibliography
of articles on double sideband techniques.
FIG. 200 - THE 200 DOUBLE SIDEBANDER TRANSMITTER.
The audio system runs across C1 and C2 volt if lower 12 AT7 delay -protective C3 500-volt, mica mounted in Ls; coil of the power supplies. All on except where otherwise specified. 0.020-inch air coupling capacitors and the 200 mmf capacitors Si are per section, 2-section HFD-140). 0.01-mfd bypass capacitors are ceramic, 1000 volts working, unless a 0.24-inch gap (Hammarlund MC-239). All fuses and holders. Resistances are K-1000; MEG=1,000,000), -watt 500-volt mica (0.001-mfd, 5000-volt ceramic type 2-pin male microphone connector (Amphenol P-111). Link Ls...28 turns 1/8 inch in diameter, 4 inches long. Shielded wires are indicated by dotted lines encircling the wire. Shielding r.f. circuitry is shown in dashed lines.

TABLE I - COIL WINDING DATA
Note: All coils are wound with theater copper wire in the sizes specified below.

<table>
<thead>
<tr>
<th>Band</th>
<th>Ind.</th>
<th>Turns</th>
<th>Wire Size</th>
<th>Wire</th>
<th>C</th>
<th>B &amp; W Number</th>
<th>Turns</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-Megacycle coils tune to the 28-megacycle band. A separate 28-megacycle exciter coil (L1) is required only when crystals oscillating at this frequency, or a VFO having output of 28 megacycles, are used with transformer.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DOUBLE SIDEBANDER

(continued from page 3)

Both power supplies are of conventional design. The high voltage supply is rated at 1000 volts DC at 145 milliamperes; and the low voltage supply delivers 360 volts DC at 110 milliamperes, both continuous duty.

ADDITIONAL CIRCUITRY on the schematic diagram includes the power supply time delay and 6146 protective circuit. A 10-ohm resistor in series with the heater to this tube (V6) increases its heating time. This prevents application of high voltage to the 816 mercury vapor rectifiers (V1 and V2) for 30 seconds and allows their filament to reach operating temperature.

When no r.f. drive is applied to the 6146's the right-hand triode of V6 has no negative bias and draws sufficient plate current through its 500,000-ohm plate resistor to nearly cut off plate current in the right-hand triode. Application of sufficient r.f. drive to the 6146's reduces plate current flow in the left-hand section of V6. This swings the grid of the right-hand section more positive, resulting in increased plate current flow which energizes relay K1. This in turn energizes K2 if S1 is in the "TRANSMIT" position, and applies primary voltage to T9.

METEERING OF ELEVEN CIRCUITS in the transmitter is accomplished with a single 0–1 milliamperre meter (M1) and the meter switch (S2). Switch positions—and the full-scale current or voltage reading in each position—are listed on the schematic diagram.

The meter measures current by reading the voltage drop (3 volts for full-scale reading) across resistances in series with the various grid and cathode circuits.

V6 and its grid form a peak detector for measuring the r.f. output voltage of the transmitter. Since the meter reads 0.707 of the peak voltage, the average r.f. power output with sine-wave modulation can be calculated, if the transmitter is operated into a non-reactive load of known impedance.

MECHANICAL LAYOUT of the r.f. unit can be determined from the pictures and explanations accompanying them. Locations of the major components and approximate dimensions have been marked on each view. The usual modern r.f. construction practices have been followed: shielding, both over-all and between stages; shielded wire for all power and metering circuit connections; liberal use of bypass capacitors, etc.

Locations of the holes for the four banana plugs, shown in the bottom view, should be marked on the main chassis to insure proper alignment. Partitions and subchassis can be fastened in place with self-tapping screws; this is much easier than attempting assembly of nuts on machine screws in tight corners! The oscillator tube sits on a small angle bracket fastened to the partition between that stage and the metering compartment.

A coil plug-in (L1) is assembled by first soldering two lengths of No. 14 tinned wire into pins 1 and 4 before winding the coil. Next the coil leads and C9 are soldered to the wires. Finally, C9 is soldered to the wires at the open end of the form.

TUNING AND OPERATION will be described in this issue—since frequent reference is made to the schematic diagram—even though constructional details for the main chassis will be covered in the next issue. (In other words, we're tuning up the rig before you've finished building it—Ed.) The procedure is similar to any transmitter having similar controls but with one exception: It is necessary to modulate the 6146 stage to obtain r.f. output.
After the usual check to see that all circuits have been wired correctly, plug in the power cord, the set of coils for the desired amateur band and turn the pi-network switch (S0) to the same position. Insert a crystal of proper frequency, or connect a stable VFO to J1, and turn S2 to the proper position. Connect a microphone to J3, and a 50-ohm dummy antenna load to J5.

Turn S2 to the "ON" position and S3 to the "TUNE" position. With S3 in position 2, tune C3 (on the oscillator coil form,) with a screwdriver until about 2 to 3 milliamperes of grid current is indicated in the driver stage. Detune this capacitor slightly if the grid current exceeds 4 milliamperes.

Next, turn S3 to position 3 and tune C4 for a dip in driver cathode current. Turn S3 to positions 4 and 5, and adjust C7 for maximum grid current in the 6146 balanced modulator. Adjust the "FA GRID DRIVE" control for a reading of 3 milliamperes in each 6146. Now, turn the "GRID CURRENT ADJUSTMENT" potentiometer until relays K1 and K2 energize, as indicated by L1 lighting. Turn the "FA GRID DRIVE" control until the 6146 grid current decreases to 2 milliamperes and again adjust the "GRID CURRENT ADJUSTMENT" until K1 and K2 open. The 6146 protective circuit is now adjusted.

To tune up the 6146 balanced modulator, set S6 on position 6, S5 on "TRANSMIT" and S2 on "SINE WAVE." Advance the "MOD. LEVEL" potentiometer (on main chassis) until the 6146 cathode current meter reading increases to 30 milliamperes. Tune C5 for a dip in plate current. Turn S3 to position 9 and adjust the "COARSE LOADING" (LOADING) control for maximum output voltage on the meter. Readjust C5 as necessary for maximum output.

Further advance the "MOD. LEVEL" control slowly to the setting at which little further increase in power output is indicated on the meter. Note this meter reading at which the balanced modulator begins to "flatten out." Next, turn S3 to the "VOICE" position and adjust the "MOD. LEVEL" control, while talking or whistling into the microphone, until the peak output voltage reading on the meter reaches the maximum level noted with sine wave modulation.

Adjustment of the "AUDIO GAIN" and "CLIPPING LEVEL" controls is best made while listening to the transmitter signal, in addition to checking it for flattening of peaks on an oscilloscope. Too much clipping will introduce serious distortion. The "AUDIO GAIN" control setting will depend upon the sensitivity of the microphone and amount of room background noise in the shack.

(Repeat II will appear in the July-August, 1959 issue.)
Many radio amateurs were intrigued by this king-size "miniature" tube—7 feet tall and 4 feet in diameter—at the 1959 IRE convention and electronics show last March at the New York Coliseum. The tube—actually a display of six basic demonstrations of the outstanding characteristics of receiving tubes—was part of General Electric's receiving tube exhibit at the show.

Based on the theme, "Tubes Do the Tough Jobs," the demonstrations included: High temperature tubes—An all-ceramic tube 15-watt audio amplifier featuring types being developed to withstand temperatures of 300 degrees centigrade, and termed "the hottest little Hi-Fi in town" (left); High power tubes—A pair of latest type power output tubes—6L6-GC's—delivering 55 watts output in class AB, audio amplifier service, with less than 2 percent total harmonic distortion (right).

The other four demonstrations were based on receiving tube reliability, high frequency performance, high voltage capability and uniformity. Viewers could actuate each display with handy controls.