T V I R E D U C T I O N

for

A M A T E U R T R A N S M I T T E R S

LIST OF ILLUSTRATIONS

TELEVISION INTERFERENCE

1.1. GENERAL.

This booklet has been written to assist in the understanding of the television interference problem and to present certain methods by which television interference may be eliminated.

The problem of interference with reception of television signals has become more important with the wide-spread installation of television receivers. These receivers are often used in secondary service areas where the television signal is extremely weak and a satisfactory picture is impossible with the presence of a very low-level interfering signal. As is the case with broadcast receiver interference by the radio amateur, the difficulty lies in many cases in the design of the receiving apparatus in the form of inadequate selectivity, poor shielding, and insufficient pre-selection. Notwithstanding the deficiencies which are usually present in receivers, Collins engineers have expended a great deal of effort in trying to solve the problem of TVI.

It has been said that the interfering signal should be attenuated to the extent that not over 50 microvolts signal is present in the vicinity of a television receiver antenna located 100 feet away. The following methods of eliminating TVI are presented for consideration realizing that as few as one or as many as all the methods may be necessary to afford satisfactory protection:

(a) Reduce spurious signals in the transmitter output.

(b) Filtering of transmitter output at the antenna terminal.

(c) Shielding of transmitter.

(d) Filtering of television receiver antenna input.

1.1.1. DISCUSSION OF TVI ELIMINATION METHODS. -

(a) and (b). The first step in the program to reduce television interference from the Model 32V was to redesign so as to reduce the spurious signals in its output. In the 32V-2 series traps are used in the exciter portions of the transmitter and an L section was added to the output network to reduce the unwanted signals to a degree which will remedy some phases of television interference. The L section in the final amplifier is particularly well adapted to the reduction of harmonic output from the transmitter. Where the receiver is located very close to the transmitting antenna, it may be necessary to add an effective low-pass filter in series with the transmitter output line. Since it is difficult to build an effective filter at high impedance, 50 ohms was selected as a convenient value because the standard 50 ohm solid dielectric coaxial cable, RG-8/U is readily available.

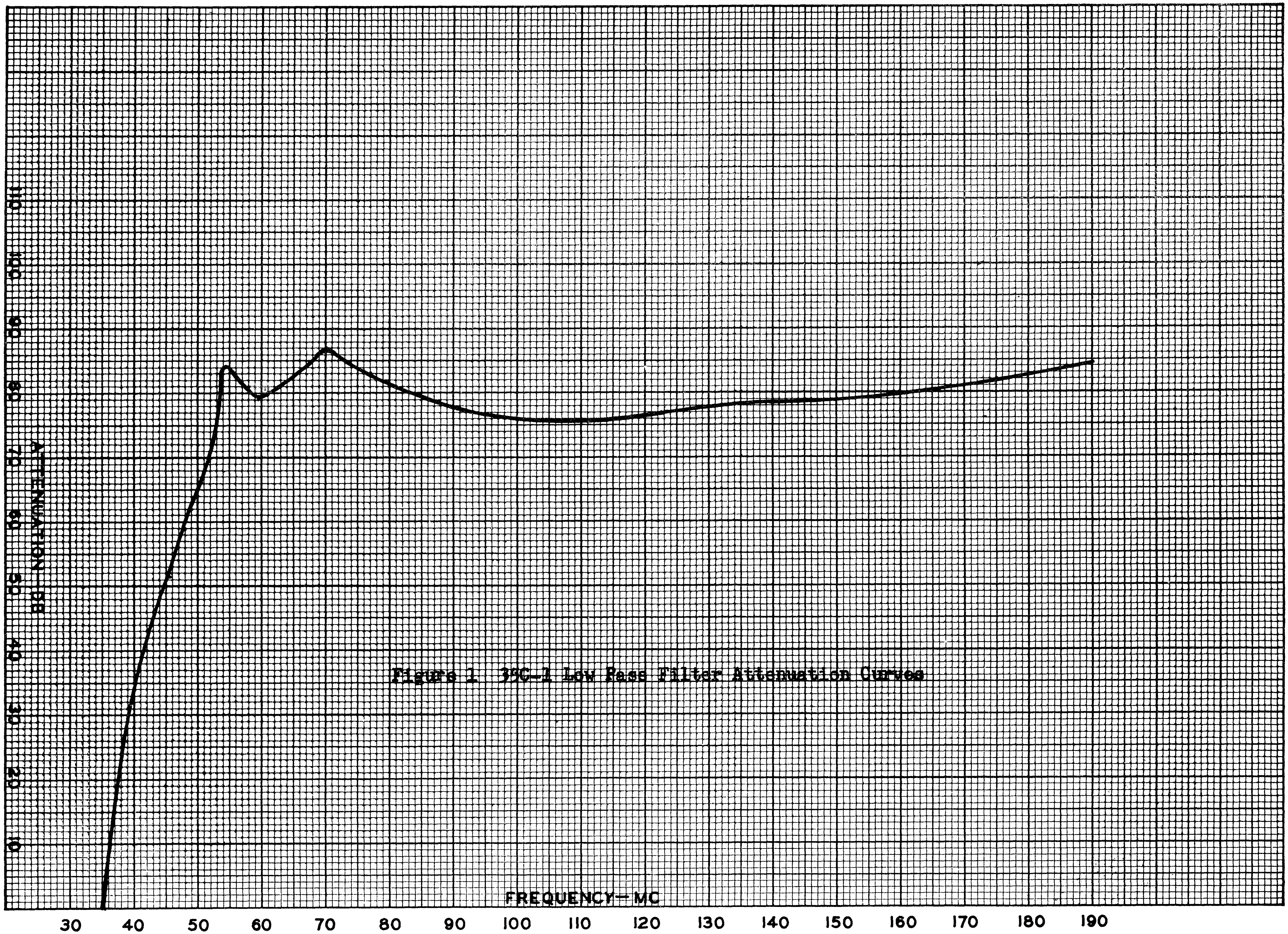


Figure 1. 35C-1 Low Pass Filter Attenuation Curves

The idea of tearing into an otherwise perfectly functioning transmitter and changing the class of operation or adding filter components is not very well accepted by most amateurs. The reasonable alternative is a well shielded, compact and highly effective external filter unit to be placed in the antenna transmission line. To make the shielding of the filter unit most effective and at the same time reduce the possibilities of complications, unbalanced output of the transmitter can be used with the result that inexpensive coaxial line can be used to connect the transmitter to the filter unit. The outer conductor of the line and the case of the filter unit can then be easily grounded. The filter can be constructed to give 70 db attenuation to all frequencies above 54 mc. See figure 1. The Collins Model 35C-1 Low Pass Filter can be connected directly to the output connector of a Collins Model 32V-2 or to the 32V-1 by replacing the antenna post with a coaxial fitting.

(c) Shielding of the transmitter can be resorted to if it is determined that direct harmonic radiation is taking place from a source other than the antenna. An integral part of any shielded transmitter should be suitable circuits filtering each wire emanating from the transmitter cabinet. Such a cabinet would be inherently air tight so in the larger transmitters, a means of forced air ventilation would likely be necessary. A completely shielded and well filtered cabinet is available for the 32V-series transmitters. This cabinet does not include the 35C-1 Low Pass Filter since it must be external to the cabinet to avoid coupling and the purchaser of a cabinet will likely have a 35C-1 filter already in service.

(d) Filtering the television receiver antenna input can be effective if it is determined that the television receiver design is susceptible to low frequency (54 mc and lower) transmitter outputs. A suitable high pass filter can be purchased or constructed from plans presented in the principal amateur publications.

1.2. DESCRIPTION AND APPLICATION OF THE 35C-1 LOW PASS FILTER.

The Collins Model 35C-1 Low Pass Filter is designed for television interference elimination where the interference is of harmonic origin. Refer to figure 2 and figure 3.

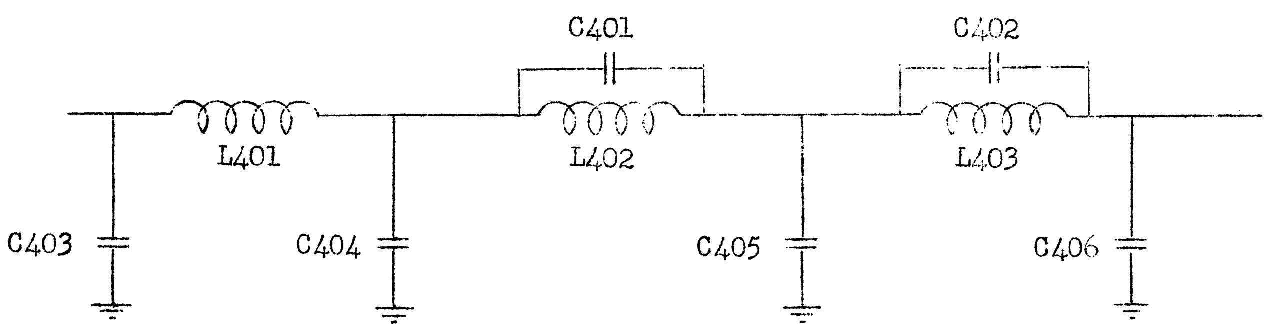


Figure 2 35C-1 Filter Schematic

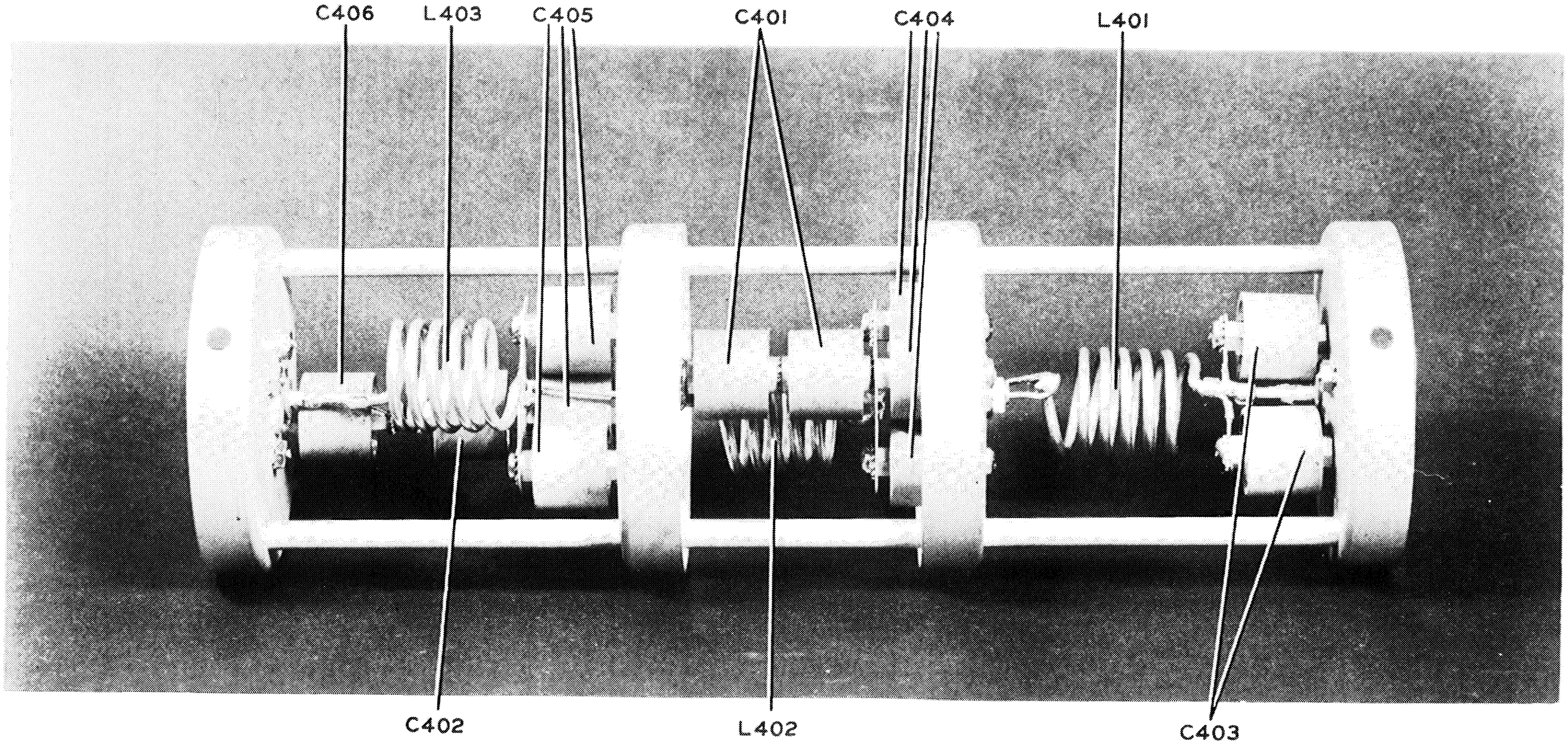


FIGURE 3. 35C-1 LOW PASS FILTER—INSIDE

Adequate shielding is assured by constructing the filter in a metal tube 3-1/8" in diameter and 10-3/8" long and by the use of coaxial input and and output fittings. The unit is provided with a pair of studs for convenient mounting in the ventilation slots on the rear of a model 32V transmitter. A short section of RG-8/U coaxial cable is furnished to connect the filter to the transmitter. The input and output impedances are 52 ohms. The output of the filter should be connected to an antenna tuner or to a transmission line having an impedance of 52 ohms appearing at its termination. The filter must never be used without proper termination on the output end since high voltages likely to be developed may possibly damage it. The filter is not as effective if it is mismatched. The filter has very low insertion loss and can be expected to attenuate all outputs higher than 54 mc at least 70 db. It is tentatively rated at 500 watts (properly terminated).

2.1. THE BALUN AND IMPEDANCE MATCHING LINE.

2.1.1. GENERAL. - Since the foregoing discussion on TVI suggests the use of an unbalanced transmitter output, a means of coupling to a balanced antenna from the filter output is in order. The usual way is to construct an antenna tuner and place it in the radiating system. A description, complete with photographs and schematics, of a suitable antenna tuner is given in the 32V instruction book. The coils shown are available at the Collins Radio Company and the other components are readily available at any radio supply house. An antenna tuner is sometimes difficult to adjust for proper loading and low loss. The system to be described here is a wide band, low loss, simple to operate system which will couple an unbalanced source to a balanced load and at the same time provide a means of matching the impedance of the source to that of the load. The load chosen here is 300 ohms because of the present popularity of the high grade transmission line commercially available at that impedance value. This system actually consists of two sections, the balun and the impedance matching tapered transmission line. Actually the balun is constructed to realize a small amount of impedance matching in itself (52 to 100 ohms). Characteristics of the balun and impedance matching line are such that over a four to one frequency range a standing wave ratio of less than 2-1 is possible, providing the system is terminated in 300 ohms resistive. The efficiency of the system is very good even beyond the specified frequency limits.

Refer to figure 4 for a chart showing the resistance and reactance characteristics of the system to be described.

2.1.2. THE BALUN. - The balun is the familiar "Bazooka" described in the antenna handbooks, with slight modifications. The balun will operate over a frequency range of 4-1 satisfactorily, therefore a frequency of 18.5 mc is chosen to construct the balun around since the 4-1 frequency ratio will allow operation from 7.0 to 30.0 mc using this frequency. See figure 5. The first four feet of the upper half of the balun (section a.) is just an extension of the 52 ohm line from the transmitter. The next eight feet (section b.) is made from RG-11/U coaxial line which has the effect of raising the impedance through the balun from 50 to 100 ohms. Section a. and Section b. are

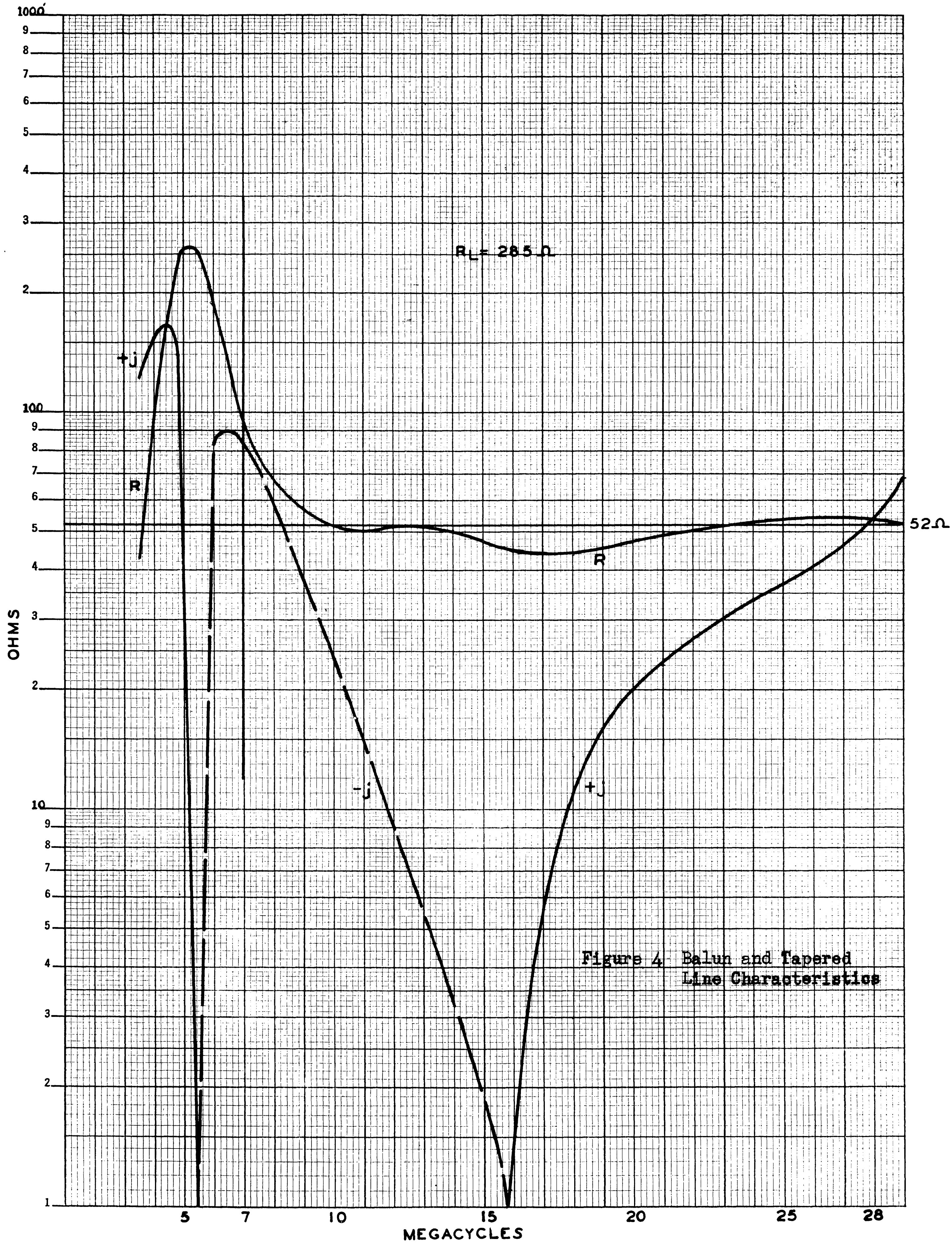


Figure 4 Balun and Tapered Line Characteristics

connected together with an 83-1J coupling. The outer conductor of the RG-11/U section connects to one of the 1" aluminum tubes, which comprise section d., by means of a special adapter. The center conductor of the RG-11/U section connects to the other 1" aluminum tube by means of an insulated wire protruding from the side of the adapter. A section of RG-8/U 12 feet long is used for the detuning section of the balun (section c.). The shield of this section is soldered to the shield of the balun input line four feet from where the RG-11/U cable connects. The center conductor is not used. At the other end, the detuning section connects to the second 1" aluminum tube by means of coaxial fittings and the special adapter. The two elements of the balun are separated with .65" spacers.

2.1.3. THE TAPERED LINE. - The purpose of the tapered line is to transform the 100 ohm impedance of the output of the balun to 300 ohms. This could be done in a single quarter wave section but much broader frequency characteristics can be obtained by using several quarter wave sections of smaller impedance jumps in series. As in the case of the balun, the length for each quarter wave section is calculated using a frequency that is the arithmetical mean of the lowest and highest frequency chosen, in this case $\frac{7 + 30}{2} = 18.5$ mc which results in lengths of about 12 feet for our quarter wave sections. The characteristic impedance of the first section following the balun is calculated at 171 ohms, which is obtained by the use of two 1" aluminum tubes spaced 11/16" apart. The impedance of the first section can be transformed to 300 ohms by a quarter wave line constructed of 12 feet of 1/2" tubing spaced 1.15" apart. The spacings mentioned are from the outside surfaces of the tubes and not from the center lines. Any type of 300 ohm resistive load can be attached to the end of the 1/4" line. The October, 1947 "Proceedings" of the IRE page 1153 contains information on this system which may be of interest.

2.1.4. ASSEMBLING THE BALUN AND TAPERED LINE. - Collins Radio Company is manufacturing a kit of parts from which a balun and tapered line can be constructed. This kit can be easily assembled using the ordinary tools found in the tool box. Assembling the system consists of attaching the adapters onto the end of the 1" aluminum pipe, placing and fastening the various spreaders, and connecting the sections of the system together. The adapters are inserted into the end of the 1" pipes (one in each pipe) and fastened with the 1/2" 8-32 screws provided. Each section of transmission line should be equipped with spreaders equally spaced within the section. After the various sections have been assembled, they can be attached together using the screws and connectors furnished. See figure 5. When using the system, connect the balun, with its attached 20 feet of RG-8/U, directly to the transmitter or to the output of a 35C-1 Low Pass Filter. Any bends in the system should be gradual and the spacings between the two conductors must be maintained.

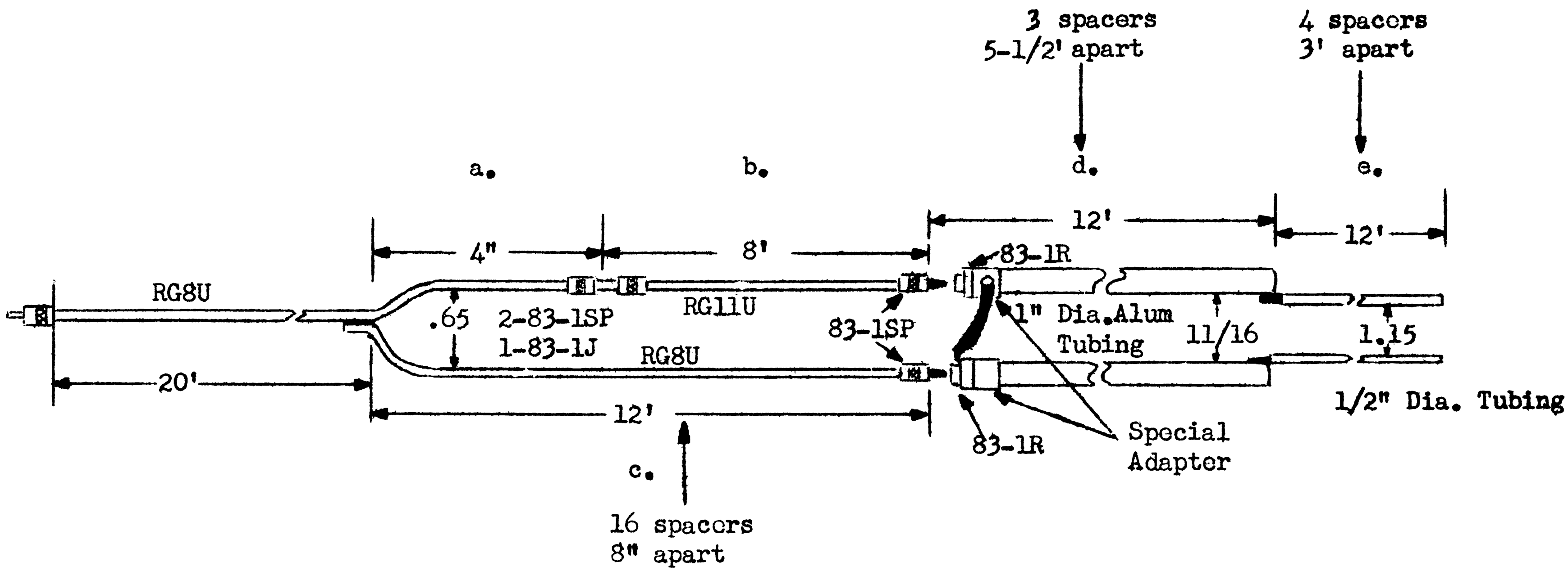
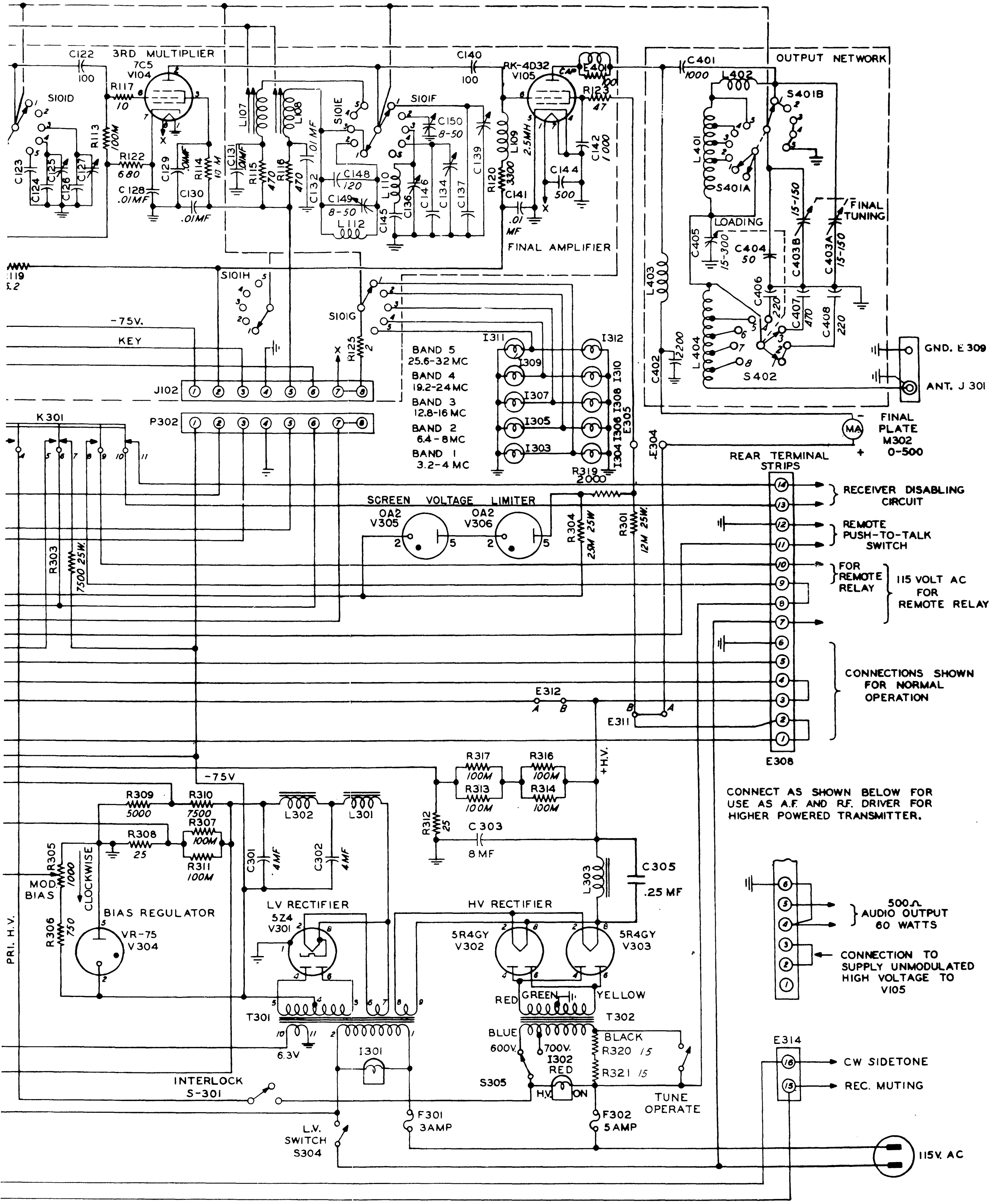


Figure 5 Balun and Tapered Line Schematic

315E-1 BALUN TRANSFORMER

DESCRIPTION	PART NAME	PART NUMBER	QUANITY
7 to 30 mc Balun	315E-1 Kit	520 4704 00	1
Balun	Cable Assembly	504 4520 002	1
No. 3	Cable Assembly	504 4526 002	1
Support	Plate	504 4525 002	1
Left	Bracket	504 4522 002	1
Right	Bracket	504 4523 002	1
1 inch	Tubing	504 4527 002	2
1/4 inch	Tubing	504 4521 002	2
No. 1 cable	Spacer	504 4517 001	17
No. 2	Spacer	504 4518 001	2
No. 3	Spacer	504 4519 001	8
Receptacle, single female contact	Connector	357 9005 00	2
Solder	Lug	304 0017 00	1
8-32 x 1-3/4	Screw	343 0319 00	8
8-32 hex	Nut	313 0054 00	16
No. 8 flat	Washer	313 0058 00	8
No. 14 bus	Wire	421 1420 00	0.2 ft
6-32 x 1-1/8 PBH	Screw	343 0337 00	17
6-32 hex	Nut	313 0053 00	34
Double ended female adapter	Connector	357 9062 00	1
4-40 x 1/4 PBH	Screw	343 0133 00	2
No. 4 shakeproof	Washer	373 8010 00	2
4-40 hex	Nut	313 0043 00	2
4-40 x 5/16 PBH	Screw	343 0286 00	8
No. 4 shakeproof	Washer	373 7010 00	8
4-40 hex	Nut	313 0051 00	8
No. 1	Cable Assembly	504 4528 003	1
No. 2	Cable Assembly	504 4524 002	1


3RD MULTIPLIER
7C5
V104
C122
100
R117
10
R113
100M
R122
680
C128
.01MF
C129
C130
.01MF
R114
S101D
C123
C124
C125
C126
C127
C131
L107
L108
R115
470
R116
470
C132
.01 MF
S101E
S101F
C148
120
C149
8-50
C150
8-50
C146
C134
C137
C139
C136
C145
L110
L112
C140
100
RK-4D32
V105
E401
R123
47
L109
2.5MH
R120
3300
C141
.01 MF
C142
1000
C144
500
FINAL AMPLIFIER
OUTPUT NETWORK
C401
1000
L402
S401B
L401
S401A
LOADING
C405
15-300
C404
50
C403B
15-150
C403A
15-150
FINAL TUNING
L403
C406
220
C407
470
C408
220
L404
S402
C402
2200
GND. E 309
ANT. J 301
FINAL PLATE
M302
0-500
R119
S101H
S101G
R125
2
-75V.
KEY
J102
P302
K301
I311
I312
I309
I310
I307
I308
I305
I306
I303
I304
E305
R319
2000
BAND 5
25.6-32 MC
BAND 4
19.2-24 MC
BAND 3
12.8-16 MC
BAND 2
6.4-8 MC
BAND 1
3.2-4 MC
E304
REAR TERMINAL STRIPS
RECEIVER DISABLING CIRCUIT
REMOTE PUSH-TO-TALK SWITCH
FOR REMOTE RELAY
115 VOLT AC FOR REMOTE RELAY
CONNECTIONS SHOWN FOR NORMAL OPERATION
SCREEN VOLTAGE LIMITER
OA2
V305
OA2
V306
R304
25M 25W
R301
12M 25W
R303
7500 25W
E312
E311
E308
CONNECT AS SHOWN BELOW FOR USE AS A.F. AND R.F. DRIVER FOR HIGHER POWERED TRANSMITTER.
500Ω
AUDIO OUTPUT
60 WATTS
CONNECTION TO SUPPLY UNMODULATED HIGH VOLTAGE TO V105
R317
100M
R316
100M
R313
100M
R314
100M
+H.V.
R312
25
C303
8 MF
L303
C305
.25 MF
-75V
R309
5000
R310
7500
R307
100M
R308
25
R311
100M
L302
L301
C301
4MF
C302
4MF
MOD. BIAS
R305
1000
CLOCKWISE
BIAS REGULATOR
R306
750
VR-75
V304
PRI. H.V.
LV RECTIFIER
5Z4
V301
HV RECTIFIER
5R4GY
V302
5R4GY
V303
T301
6.3V
I301
RED
GREEN
YELLOW
T302
BLUE
BLACK
600V.
700V.
I302
RED
R320 15
R321 15
S305
H.V.
ON
TUNE
OPERATE
INTERLOCK
S-301
F301
3AMP
F302
5 AMP
L.V. SWITCH
S304
E314
CW SIDETONE
REC. MUTING
115V. AC

ic Diagram

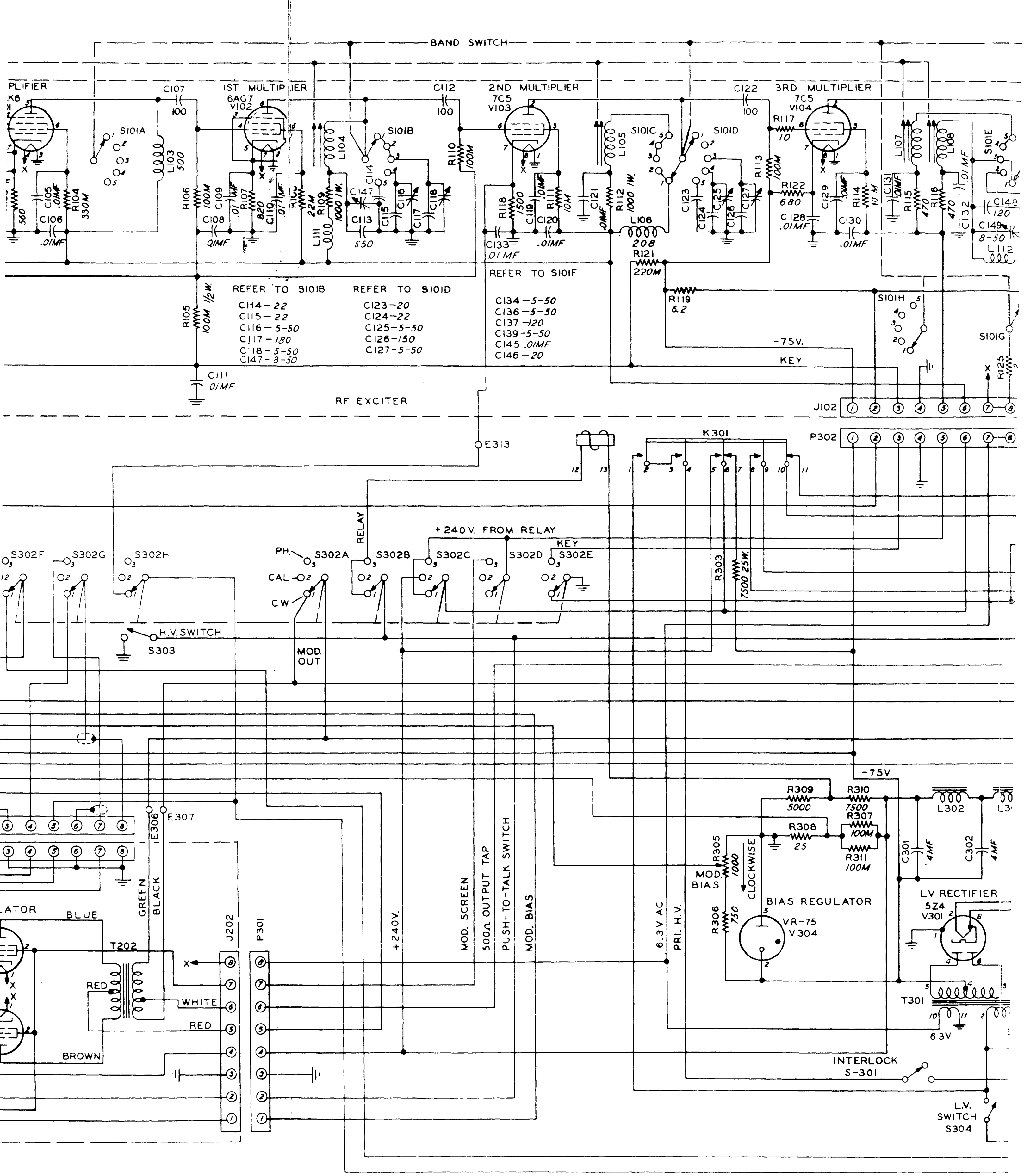


Figure 5-8 Model 32V-2 Complete Schematic Diagram

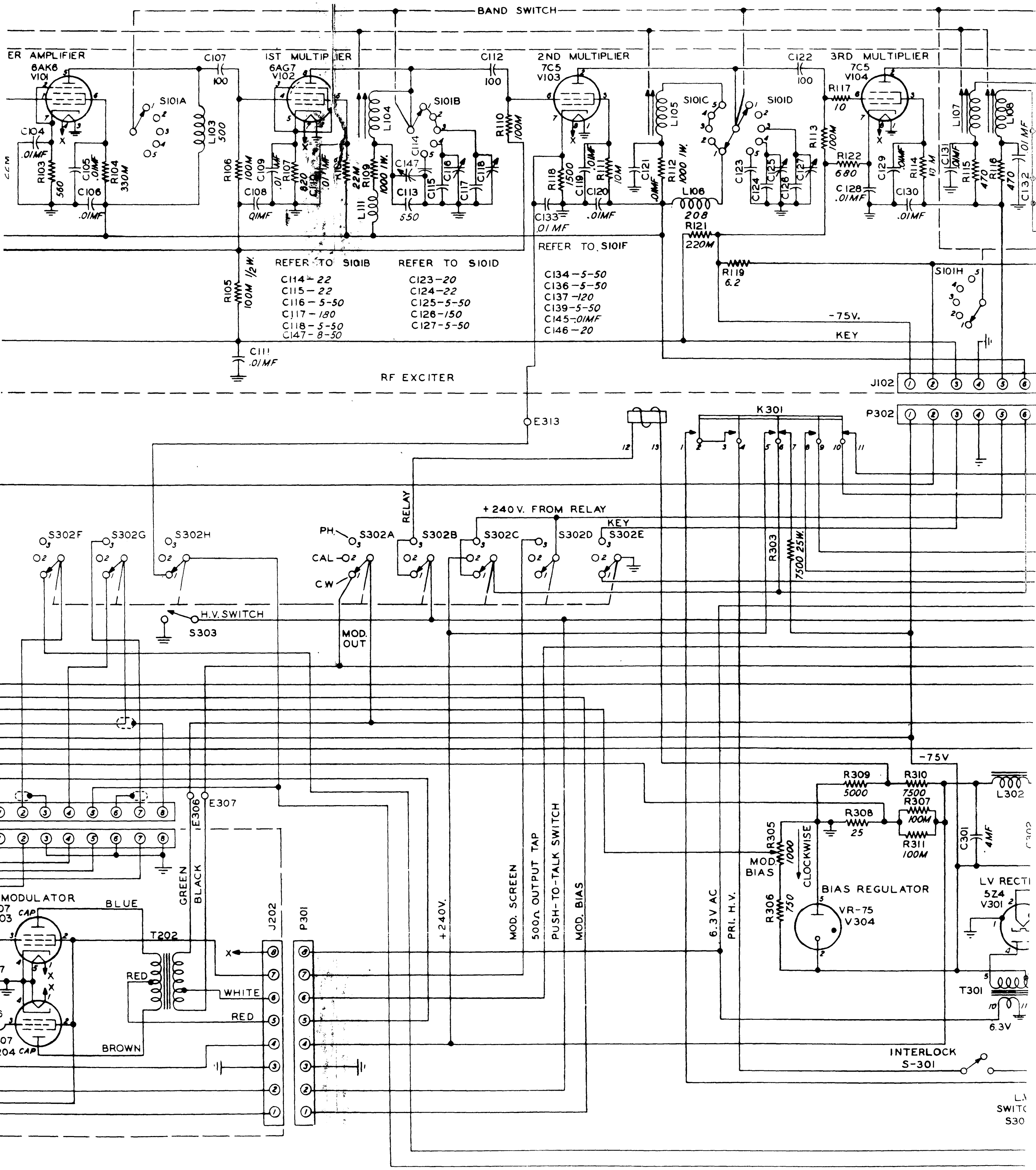
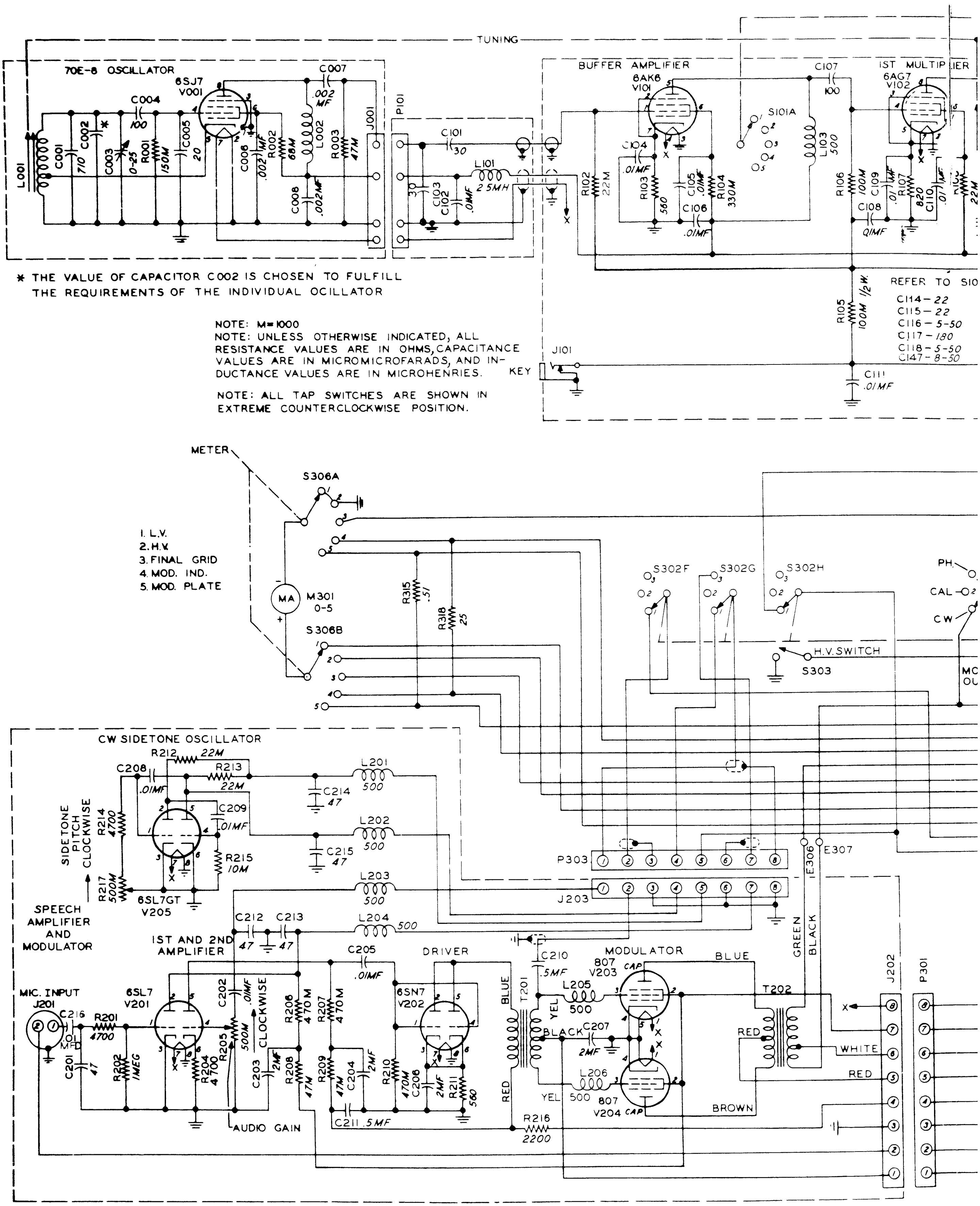


Figure 5-8 Model 32V-2 Complete Schematic Diagram



TUNING
70E-8 OSCILLATOR
6SJ7
V001
C007
C004
100
C001
710
C002
C003
0-25
R001
150M
C005
20
C006
.002MF
R002
68M
L002
R003
47M
C008
.002MF
J001
P101
C101
30
L101
2.5MH
C103
C102
.01MF
BUFFER AMPLIFIER
6AK6
V101
C104
.01MF
R102
22M
R103
560
C105
.01MF
R104
330M
C106
.01MF
S101A
L103
500
C107
100
IST MULTIPLIER
6AG7
V102
R106
100M
C109
R107
820
C108
.01MF
C110
R105
100M 1/2W.
REFER TO S10
C114-22
C115-22
C116-5-50
C117-180
C118-5-50
C147-8-50
J101
KEY
C111
.01MF
* THE VALUE OF CAPACITOR C002 IS CHOSEN TO FULFILL THE REQUIREMENTS OF THE INDIVIDUAL OSCILLATOR
NOTE: M=1000
NOTE: UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROMICROFARADS, AND INDUCTANCE VALUES ARE IN MICROHENRIES.
NOTE: ALL TAP SWITCHES ARE SHOWN IN EXTREME COUNTERCLOCKWISE POSITION.
METER
S306A
1. L.V.
2. H.V.
3. FINAL GRID
4. MOD. IND.
5. MOD. PLATE
MA
M301
0-5
S306B
R315
.51
R318
25
S302F
S302G
S302H
H.V. SWITCH
S303
PH.
CAL
CW
CW SIDETONE OSCILLATOR
R212 22M
R213 22M
C208
.01MF
C209
.01MF
L201
500
C214
47
L202
500
C215
47
R214
4700
SIDETONE PITCH CLOCKWISE
R215
10M
R217
500M
6SL7GT
V205
L203
500
SPEECH AMPLIFIER AND MODULATOR
C212
47
C213
47
L204
500
IST AND 2ND AMPLIFIER
P303
J203
E306
E307
GREEN
BLACK
C205
.01MF
DRIVER
C210
.5MF
MODULATOR
BLUE
807
V203
MIC. INPUT
J201
C216
.01 MFD
R201
4700
6SL7
V201
C202
.01MF
CLOCKWISE
R206
470M
R207
470M
6SN7
V202
L205
500
T201
YEL
BLACK
C207
2MF
T202
RED
WHITE
C201
47
R202
1MEG
R204
4700
R205
500M
C203
2MF
R208
47M
R209
47M
C204
2MF
R210
470M
C206
2MF
R211
560
L206
500
YEL
807
V204
RED
BROWN
AUDIO GAIN
C211 .5MF
R216
2200
J202
P301

Figur