## SECTION III

# RADIO-FREQUENCY AMPLIFIER UNIT CRV-50096

## TECHNICAL SUMMARY

### ELECTRICAL CHARACTERISTICS—

Tuning Range ........ 3 to 24 megacycles
Number of Bands ........ 3
Band Coverage ........ 3 to 6 mc, 6 to 12 mc, and 12 to 24 mc
Antenna Matching Impedance ........ 125 ohms balanced
Overall R-F Gain (Approximate)

| 3 to 6-MC Band | 6 to 12-MC Band | 12 to 24-MC Band |
|---|---|---|
| 1,800- 4,700 at 3 mc | 1,250-2,300 at 6 mc | 3,300- 5,600 at 12 mc |
| 4,100-11,000 at 4.5 mc | 3,000-5,100 at 9 mc | 5,000-11,000 at 18 mc |
| 5,000-17,000 at 6 mc | 3,300-5,400 at 12 mc | 3,500- 8,000 at 24 mc |

Conversion Gain (average) ........ 1 to 2

### TUBE COMPLEMENT—

R-F Amplifiers ........ 9 RCA-36
Oscillator ........ 3 RCA-37
Detector ........ 3 RCA-78

### MECHANICAL SPECIFICATIONS—

Dimensions—
Panel Size ........ 19 inches (width) by 27 31/32 inches (height)
Unit Depth ........ 8¼ inches
Weight (net) ........ 83 pounds

## DESCRIPTION

The radio-frequency amplifier unit has been designed especially for use with the space diversity receiving system. Its purpose is to select and amplify the desired signal and also to convert that signal through heterodyne action to a suitable intermediate frequency. The amplifier stages may be operated either with fixed gain or with automatic gain control (AGC). In the latter case, such control is obtained from one of the associated units comprising the equipment. An outstanding feature of this unit is the isolation of the heterodyne oscillator from the remainder of the circuit, insuring absence of cross-talk between receivers even in large communication stations.

Three separate and complete radio-frequency chains are contained in this unit. Each chain covers one frequency band and consists of an input coupling coil, three stages of tuned r-f amplification, a heterodyne oscillator and a heterodyne detector. Transfer from one band to another is accomplished by means of a three-position switch that supplies filament voltage to only those tubes in the chain selected. This arrangement provides sufficient flexibility, maximum ease of operation and elimination of troubles generally experienced with plug-in coils. Another advantage is that there are no switch contacts required in the low-loss r-f tuned circuits. The resulting reliability of performance and simplicity of design are well worthwhile, particularly in equipment intended for handling important services.

The use of three r-f bands for covering the total frequency range has several advantages. Since each band covers only a two-to-one frequency range, the input coupling coils are reasonably uniform with respect to noise equivalent and transmission-line loading. The three band ranges correspond approximately to the ranges of frequencies employed during the day time, evening and night hours, respectively. Thus it is possible to pretune the r-f circuit from calibration cards before changing from a day signal to

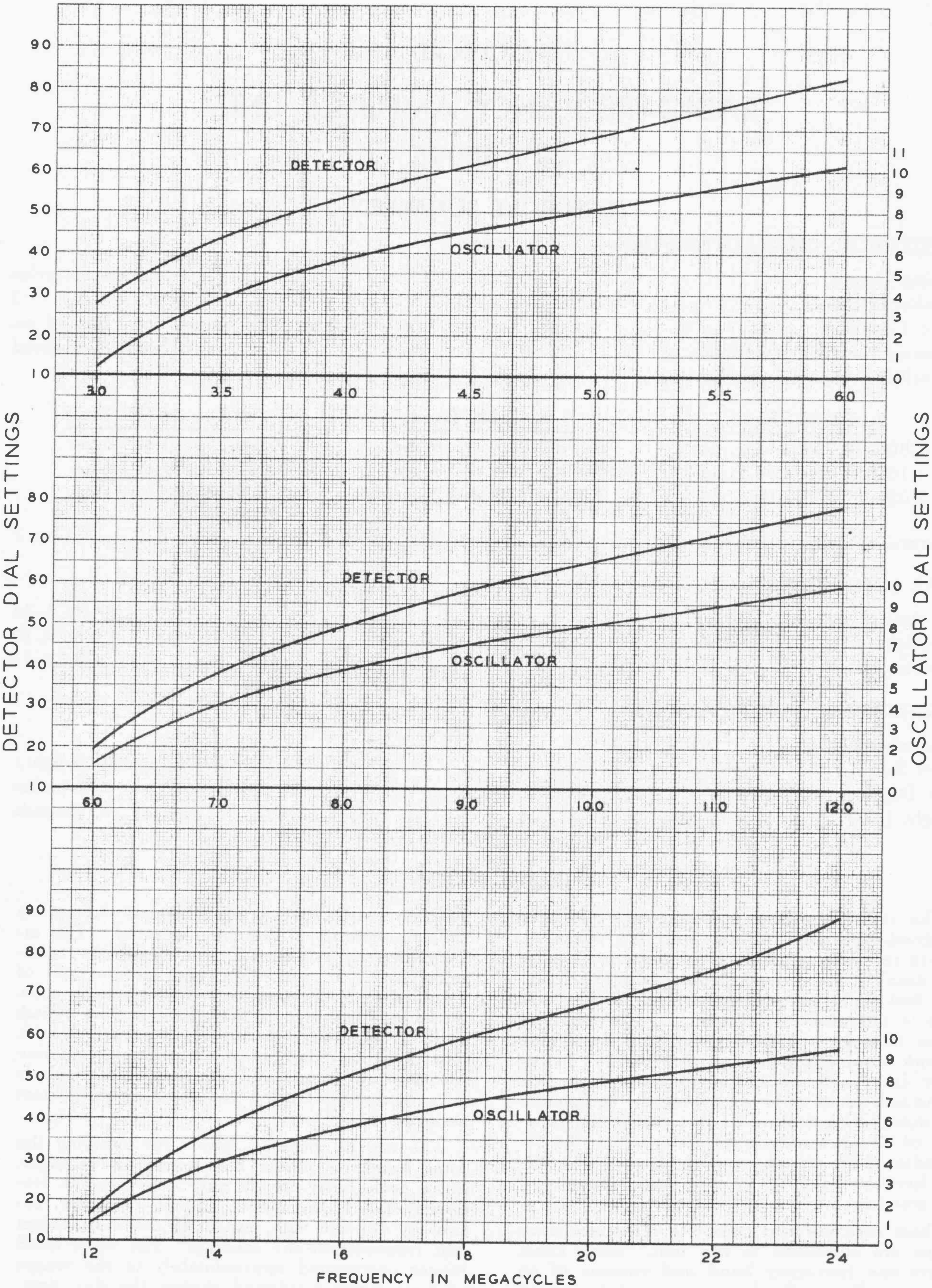



*Figure 1—Radio-Frequency Amplifier Unit*
*(Tracking Characteristics, S-852937—Sub* 0)

a night signal, the actual changeover then consisting of only turning the range switch, shifting the input connection and touching-up the tuning adjustments.

Each of the input coupling coils is adjustable to eliminate overloading on very strong signals, such adjustment being provided by the three small knobs on the front of the unit near the top. An electrostatic shield is interposed between each coil and its corresponding tuned circuit to prevent capacitive coupling. Proper performance of the horizontal rhombic and "fishbone" antennas depends upon responsiveness of the entire system to only horizontal polarized waves. This means that the system must be symmetrical with respect to ground and that the output shall be taken only from wire to wire of the transmission line and not from line to ground. Such a condition can be realized only when the coupling between the antenna system and the first tuned circuit is purely inductive. Capacitive coupling would impair the directive characteristics of the antenna system.

All of the r-f circuits are individually tuned to insure maximum selectivity and simplify maintenance. The first tuned circuit of each band is designed to give the lowest possible noise equivalent throughout its frequency range. On the 3- to 6-mc and 6- to 12-mc bands, additional damping is provided in the second, third and fourth tuned circuits to keep the variation of gain with respect to frequency within reasonable limits and yet maintain the required selectivity. The fourth tuning inductors are tapped at points to obtain the desired value of overall gain and minimum interaction between the detector grid and heterodyne oscillator circuits. The tracking characteristics of a typical receiver are shown in Figure 1.

Automatic gain control (AGC), is normally employed on all r-f stages. In addition to maintaining constant output from the equipment, this feature serves to keep the signal level at the heterodyne detector reasonably low. Transfer from AGC to fixed bias, or the reverse, is afforded by means of the small toggle switch on the front panel. Manual gain control is available at all times by means of a potentiometer for adjustment of the screen-grid voltage supplied to the amplifier tubes. As noted above, separate tubes are employed for the heterodyne detector and oscillator stages. The screen-grid and bias voltages and the suppressor grid voltage of the detector tube are adjusted to give an essentially linear modulation action. This means that distortion and harmonic generation in the detector stage will be at a minimum. Spurious responses of the receiver as a whole, therefore, will be minimized; also, such frequencies differing from that of the desired signal by submultiples of the output (first intermediate) frequency. The detector output system is designed to work into the tuned input circuit of the associated i-f amplifier unit which is described in Section IV.

To prevent bothersome frequency drift of the heterodyne oscillators when operation is switched from one band to another, the filaments of all three oscillator tubes are kept heated at all times. However, plate voltage is applied only to that tube which is in use, thus eliminating any possibility of spurious beat notes from the other two. In contrast, only the filament circuits of the r-f amplifier tubes are switched when changing frequency bands. Power supply circuits and low-frequency filtering are common to the three r-f bands with the exception of the oscillators.

Special shielding of the oscillator tank circuit, oscillator tube and associated elements insures freedom from troublesome radiation into the input coupling coils, antenna transmission lines and other receivers. The importance of adequate shielding is apparent when it is considered that approximately ten volts of oscillator signal is applied to the detector tube and that the receiver will operate on input signals of one microvolt or less. There are the three small knobs located on the front of the unit near the bottom to control the oscillator vernier tuning capacitors. The oscillator tubes are located inside the individual rectangular shields (see Figure 3) which are readily detachable upon removing the knobs.

To enable rapid tuning, there is provided on the front panel unit a card file for calibration and signal logging. Ready availability of accurate and complete tuning calibrations will be found to save much time in locating and identifying signals. The card file is divided into three groups, each group corresponding to one of the three frequency bands and distinguished by a separate color. An indicator card listing frequencies throughout the particular band is placed at the top of a group of ten signal calibration cards of the same color. The five spaces in each vertical row (on these indicator cards) correspond to the five tuning dials in any one chain of the unit. Dial settings for nominal frequencies are entered during factory test of the equipment.

The signal calibration cards, will each accommodate complete tuning calibration for three signals, one in each of the three vertical columns. The upper five spaces correspond to the dials of any one chain in the unit and dial settings are entered in them. The three spaces at the bottom of each column may be used in various ways. Usually the space just below the double line is used for entering the designation of the best antenna for that signal, while the second and bottom spaces are employed to designate the call letters and the frequency of the signal. Entering of frequency on the bottom space is advantageous in that it permits arrangement of the calibrations according to frequency. Calibrations for even hundreds of kilocycles may then be inserted between the calibrations for specific signals. These will often be found to be very useful when hunting for new signals or ones not previously used.

## OPERATION

Operation of the r-f amplifier unit is covered in sufficient detail under the operation of the system and reference should be made to Section I for procedure. In general, tuning consists of adjusting the unit for operation within the proper frequency band and setting the individual dials for the band involved.

The range switch is located at the left just above the plate milliammeter (see Figure 2) and the three positions are clearly identified by nameplates which indicate the band frequency limits. Corresponding nameplates are provided on the main door of the unit below the respective vertical rows of dials. In each row from top to bottom, the dials serve to control the first, second and third r-f amplifier stages, the heterodyne detector and the oscillator. Input coupling is controlled by the small knobs just below the uppermost dials while vernier tuning of the oscillator is accomplished by the small knobs at the bottom.

Choice of AGC or fixed gain is afforded by the toggle switch just beneath the plate milliammeter. The knob slightly to the right of this switch enables manual control of gain in either condition of operation. Recommendations for proper use of the AGC system are included within Section I.

In tuning, the total plate current of the three r-f amplifier stages may be observed on the milliammeter. Jacks are available at the bottom of the panel for determining the individual plate currents of the detector and oscillator circuits.

To facilitate retuning operations, the dial settings for each station should be logged in the card index file. Settings for nominal frequencies are shown on the indicator card preceding each group of signal calibration cards.

## SERVICE

In the event of failure within the r-f amplifier unit, reference should be made initially to the portion of Section I dealing with "Maintenance." The proper procedure for locating the defective unit is outlined therein and this section therefore will be limited to specific information for replacement and repair of such parts.

### RANGE SWITCH

To replace the range switch, first remove the knob by pulling it forward and turning it counterclockwise until it is loose. The switch itself is then removed by simply unscrewing the two rear screws which hold it in place on the mounting spacers. Do not attempt to loosen the screws on the front of the unit. If wires must be unsoldered, a fairly large and very hot soldering iron should be used so as to avoid undue heating of the contact arm. All wires should be tagged before removal, to facilitate reconnection when replacement is made.

### TUNED CIRCUITS

All design data necessary for rewinding the coil of any tuned circuit assembly are shown in the accompanying table and parts list. Any assembly may be withdrawn simply by removing four screws at the front and detaching the wires which pass through to the rear of the chassis. Care must be taken not to disturb appreciably the arrangement of these wires in removing the assembly from the chassis. This precaution is especially important in the case of the red (plate) leads in the 12- to 24-megacycle assemblies. In no case should this wire be cabled up with the plate supply and bias wire since the tuning calibration at the high-frequency end of the range would be seriously affected. It is possible that the upper limit of the tuning range may be reduced by such practice from somewhat over 24 megacycles to perhaps 22 megacycles, or even lower. The screws which secure the shield cans to the chassis must be kept well tightened to avoid instability or oscillation in the r-f stages.

## TUNED CIRCUIT DESIGN DATA

| Band | Coil Data | Antenna Coupling | 1st RF | 2nd RF | 3rd RF | Detector | Oscil-lator |
|---|---|---|---|---|---|---|---|
| 3 to 6 MC | Wire Size (AWG No.) | 36 DSC | 28 | 28 | 28 | 28 | 28 |
| | Turns per inch | — | 40 | 40 | 40 | 40 | 40 |
| | Total Turns | 20 | 40 | 40 | 40 | 40 | 38 |
| | Taps: Bias or ±125 | — | 0 | 0 | 0 | 0 | — |
| | Taps: Grid & Plate | — | 20 | 18 | 18 | 18 | — |
| | Taps: Damping Ohms | — | — | 100000 | 100000 | 100000 | — |
| | Taps: Stator of Condenser | — | 40 | 40 | 40 | 40 | — |
| | Taps: Grid Rotor | — | — | — | — | — | 0 |
| | Taps: ±125 Supply | — | — | — | — | — | 9 |
| | Taps: Detector G-3 | — | — | — | — | — | 12½ |
| | Taps: Plate Stator | — | — | — | — | — | 38 |
| 6 to 12 MC | Wire Size (AWG No.) | 36 DSC | 22 | 22 | 22 | 22 | 22 |
| | Turns per inch | — | 20 | 20 | 20 | 20 | 20 |
| | Total Turns | 10 | 18 | 18 | 18 | 18 | 18 |
| | Taps: Bias or ±125 | — | 0 | 0 | 0 | 0 | — |
| | Taps: Grid & Plate | — | 12 | 9 | 9 | 9 | — |
| | Taps: Damping Ohms | — | — | 100000 | 100000 | 100000 | — |
| | Taps: Stator of Condenser | — | 18 | 18 | 18 | 18 | — |
| | Taps: Grid Rotor | — | — | — | — | — | 0 |
| | Taps: ±125 Supply | — | — | — | — | — | 5½ |
| | Taps: Detector G-3 | — | — | — | — | — | 7 |
| | Taps: Plate Stator | — | — | — | — | — | 18 |
| 12 to 24 MC | Wire Size (AWG No.) | 36 DSC | 16 | 16 | 16 | 16 | 16 |
| | Turns per inch | — | 10 | 10 | 10 | 10 | 10 |
| | Total Turns | 6 | 8 | 8 | 8 | 8 | 8 |
| | Taps: Bias or ±125 | — | 0 | 0 | 0 | 0 | — |
| | Taps: Grid & Plate | — | 8 | 6 | 6 | 6 | — |
| | Taps: Damping Ohms | — | — | — | — | — | — |
| | Taps: Stator of Condenser | — | 8 | 8 | 8 | 8 | — |
| | Taps: Grid Rotor | — | — | — | — | — | 0 |
| | Taps: ±125 Supply | — | — | — | — | — | 2½ |
| | Taps: Detector G-3 | — | — | — | — | — | 3½ |
| | Taps: Plate Stator | — | — | — | — | — | 8 |

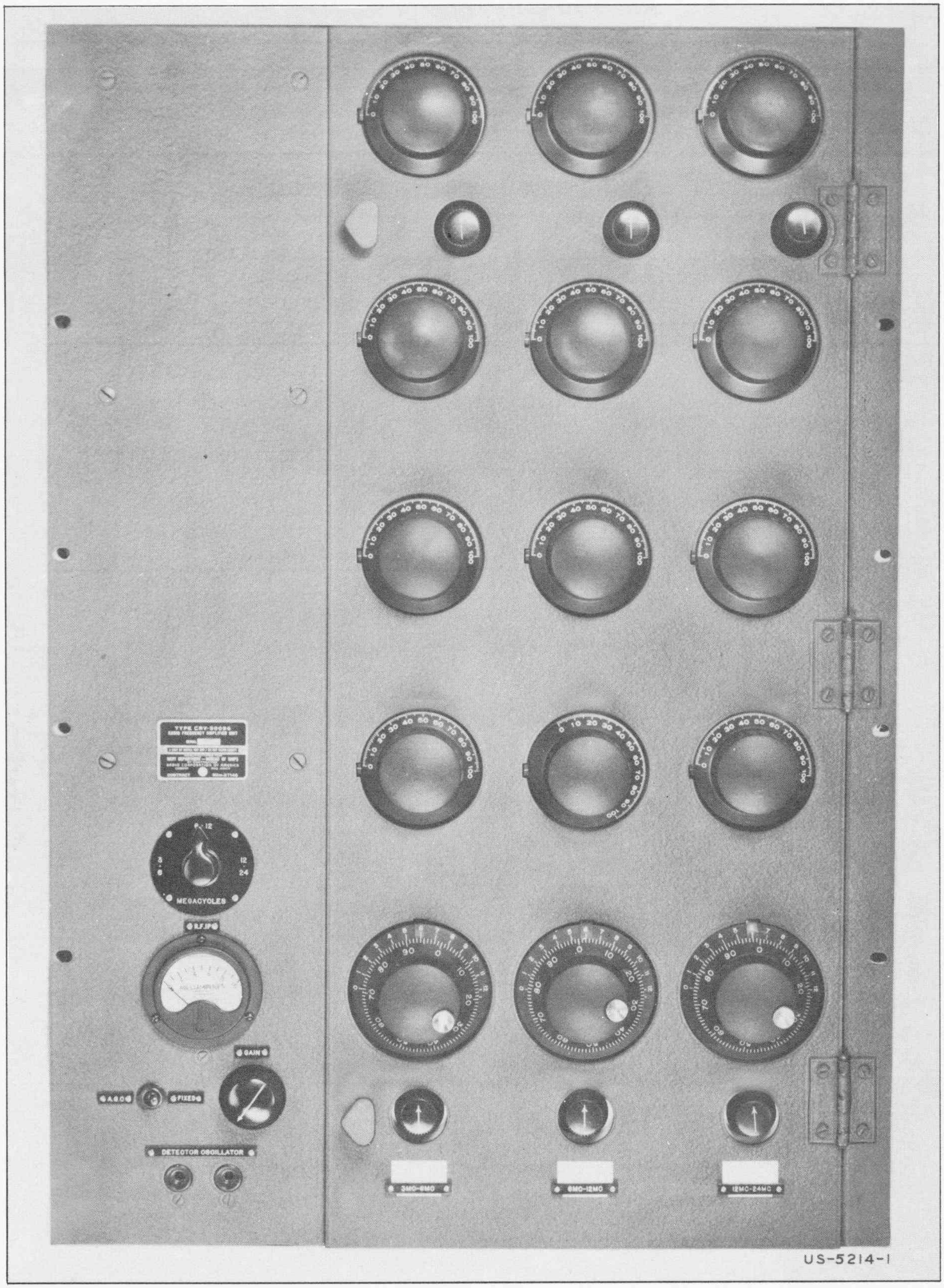



*Figure 2—Type CRV-50096 Radio-Frequency Amplifier Unit (Front View, Tube Access Door Closed)*

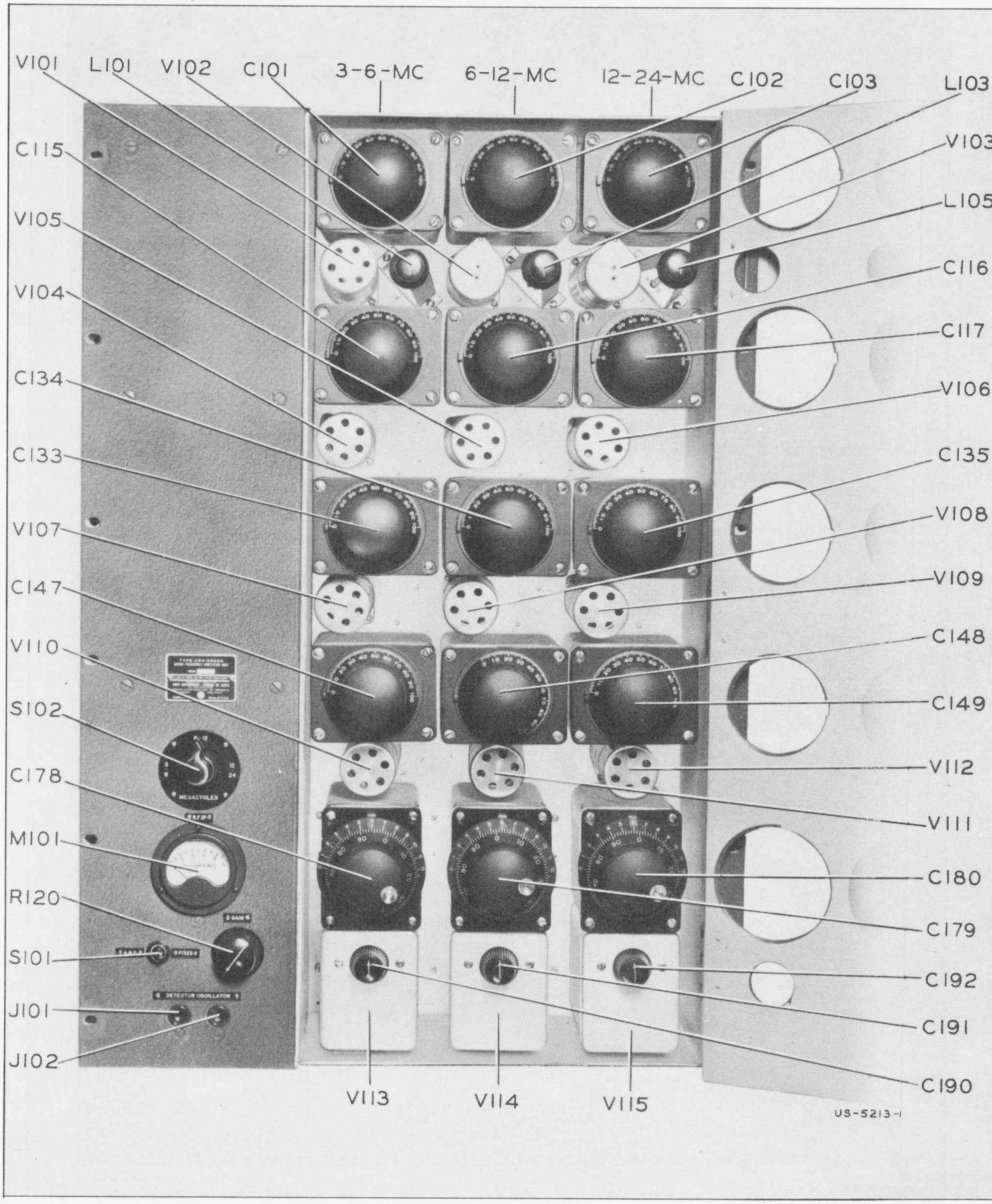



*Figure 3—Type CRV-50096 Radio-Frequency Amplifier Unit (Front View, Tube Access Door Open)*

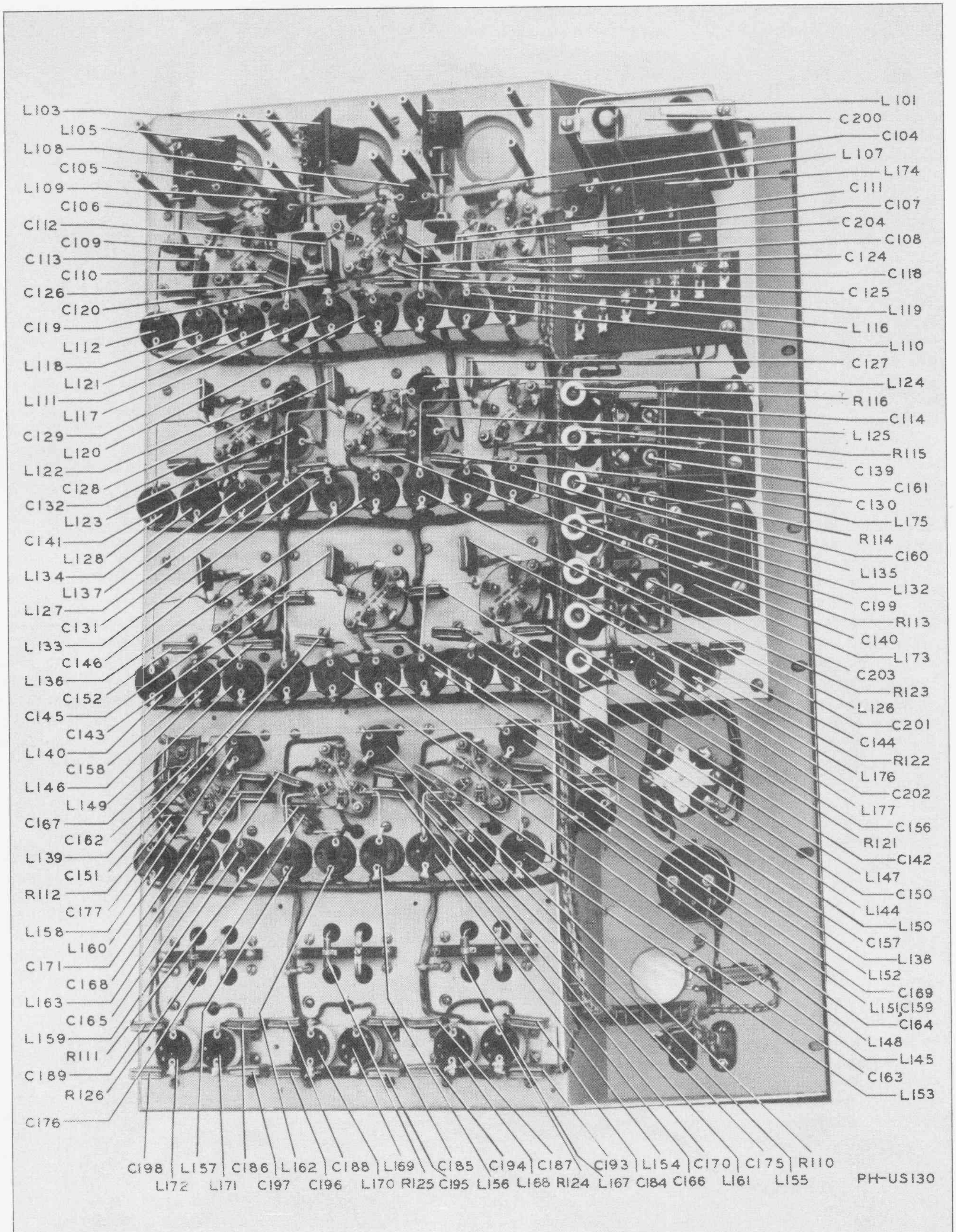



*Figure 4—Type CRV-50096 Radio-Frequency Amplifier Unit (Rear View, Cover Removed)*

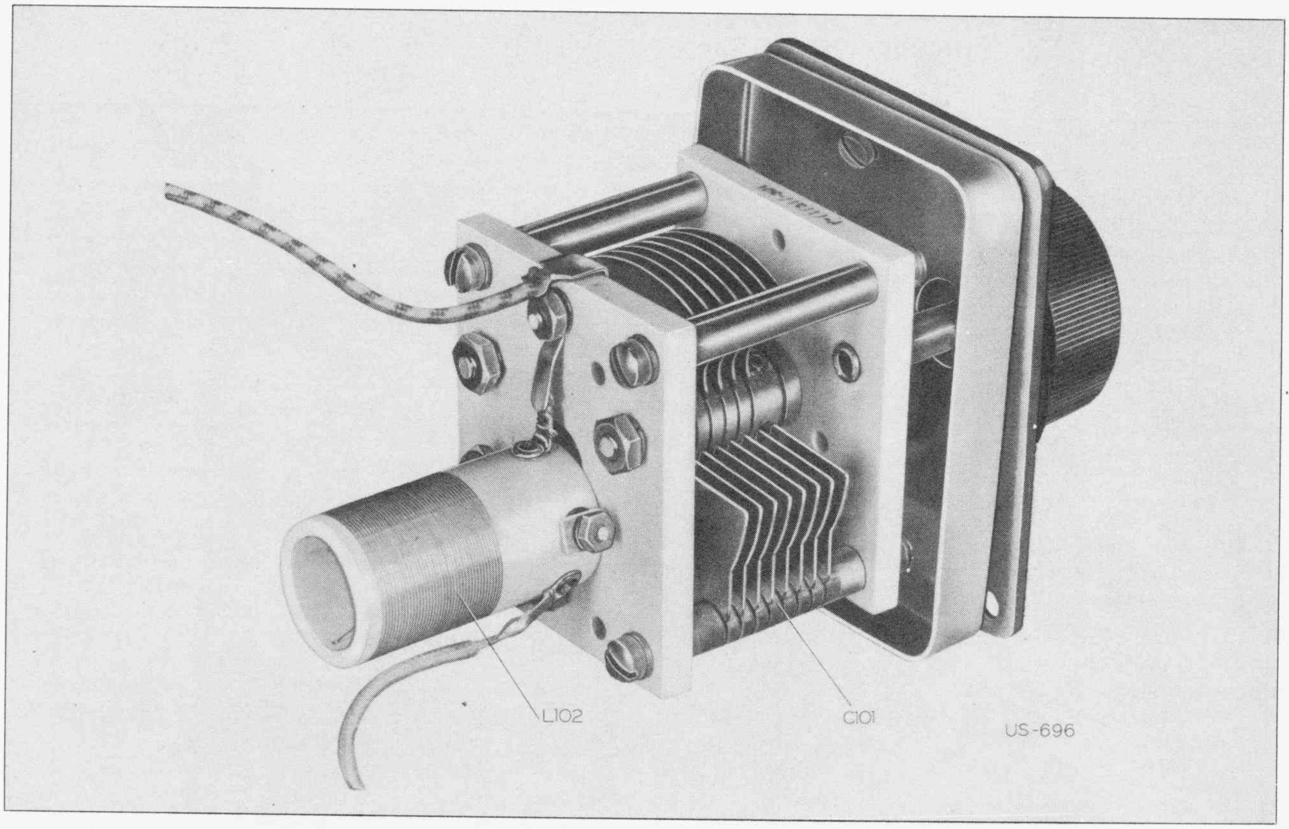



*Figure 5—Typical Circuit Assembly (First Stage, 3 to 6 MC Band)*

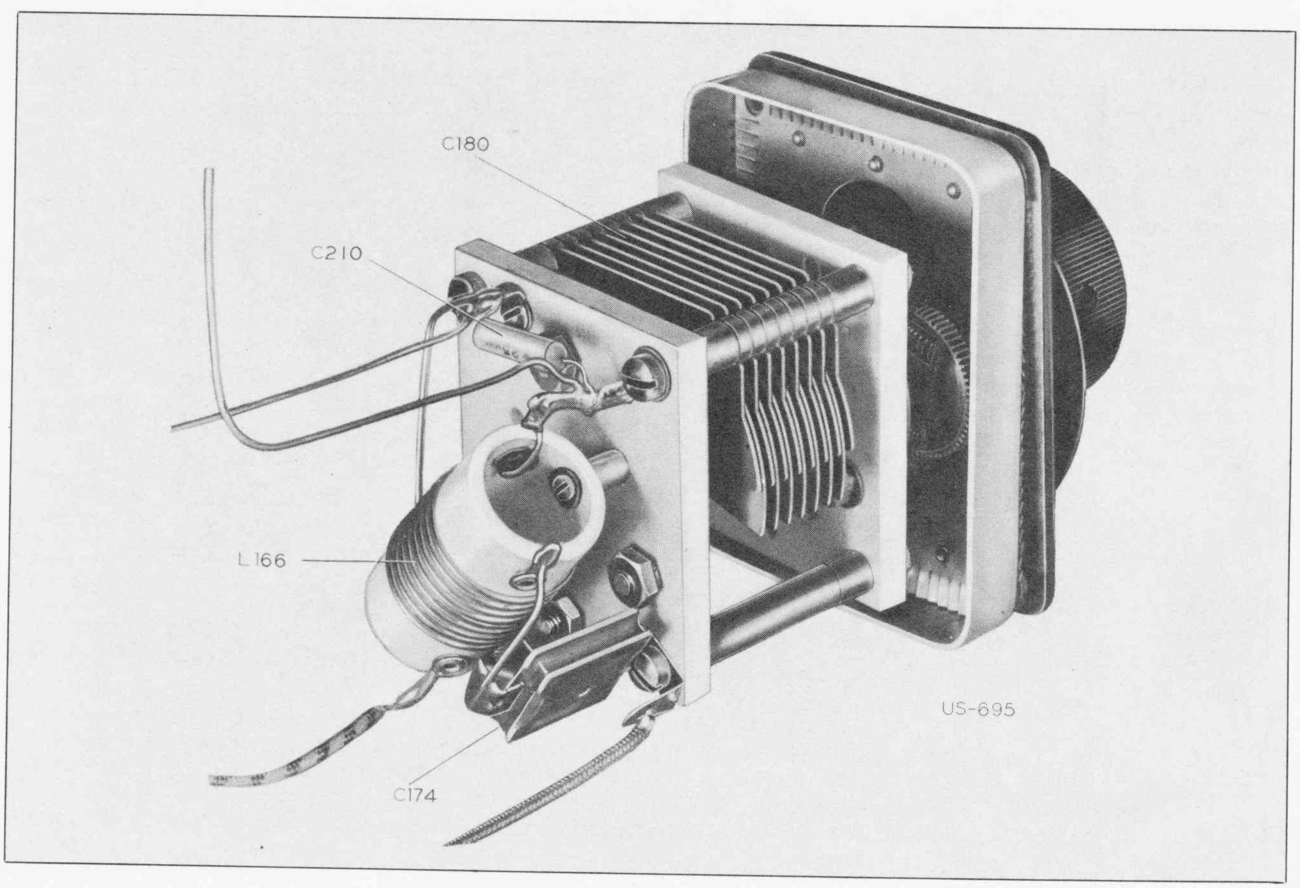
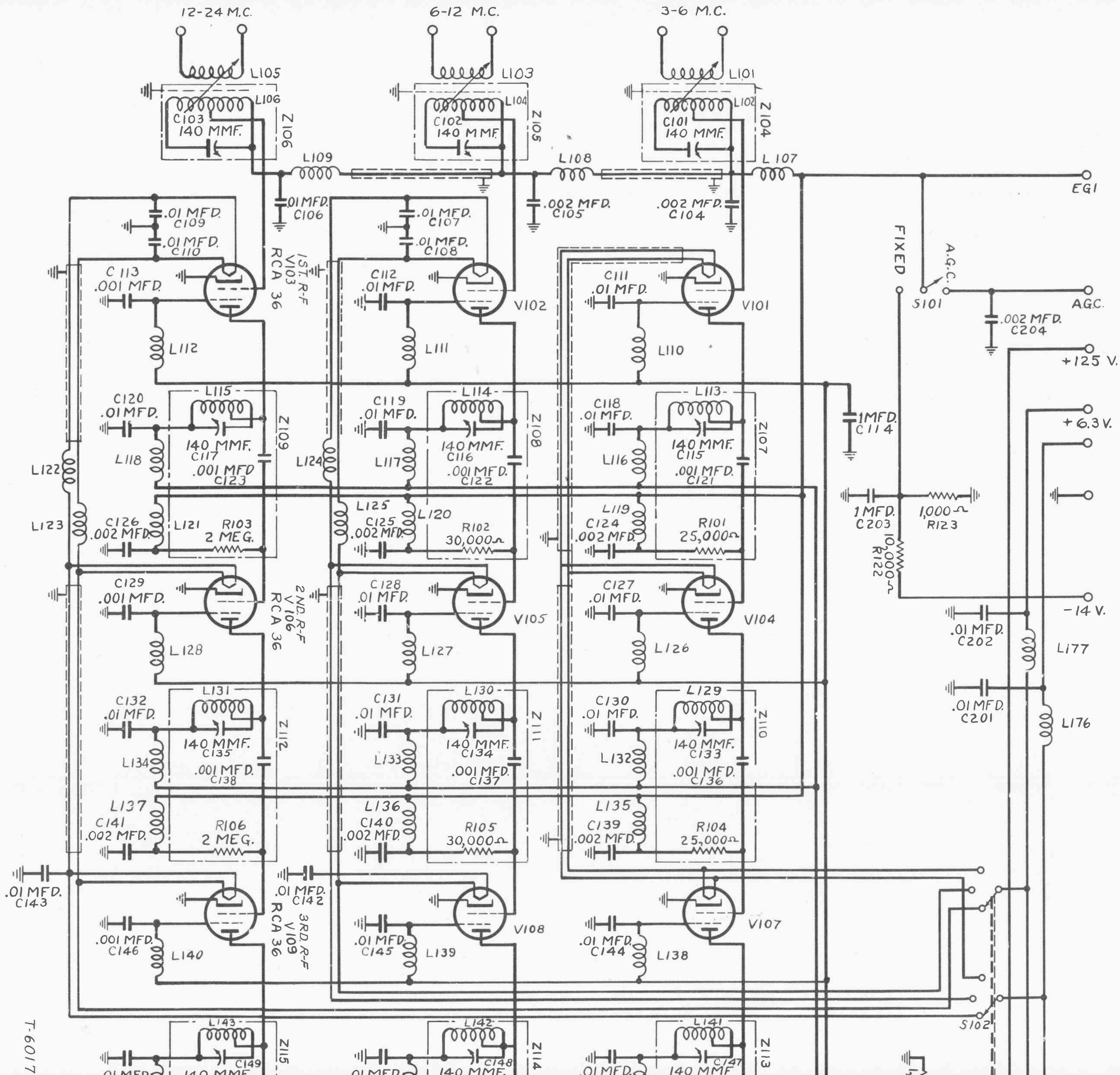
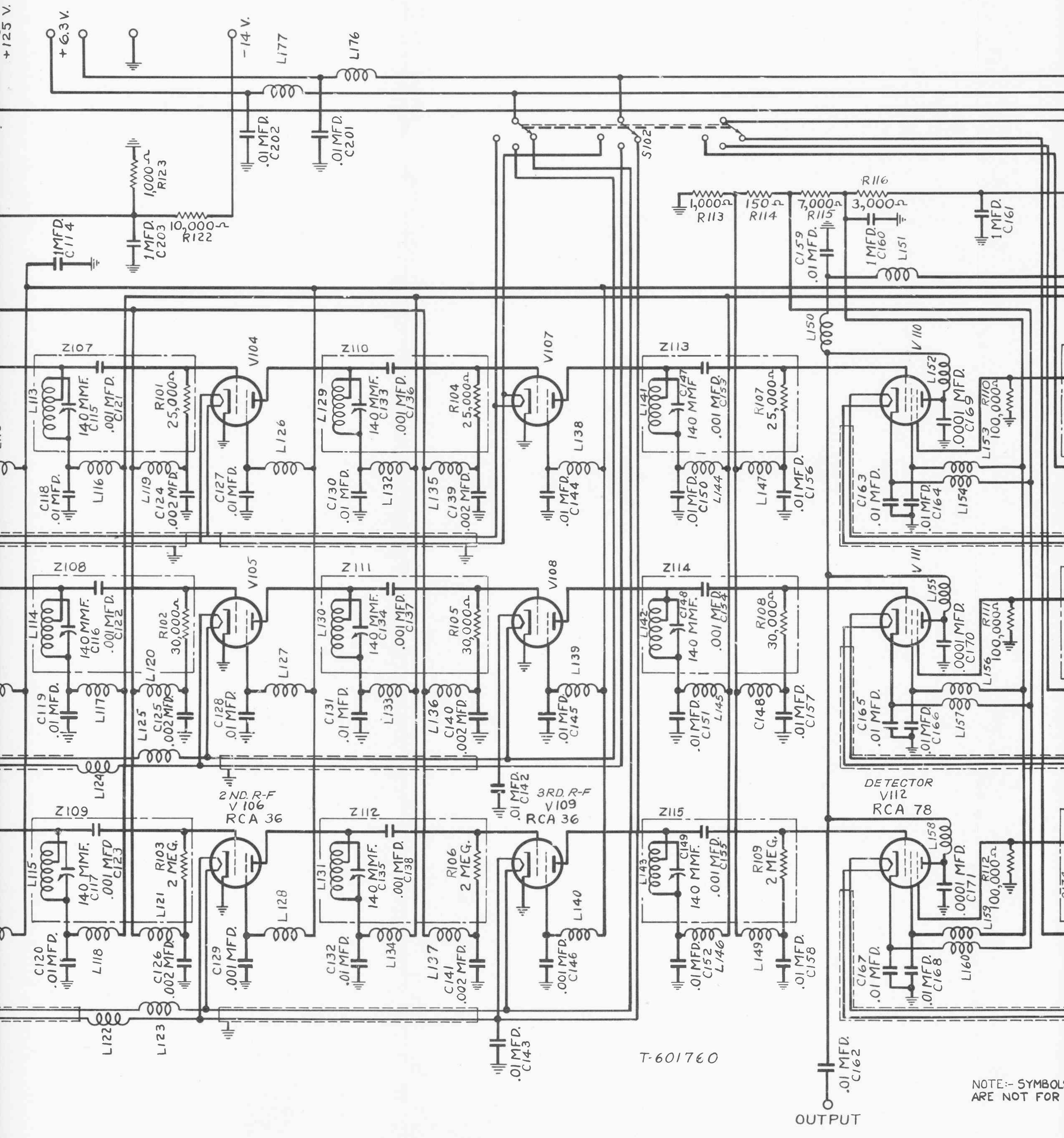



*Figure 6—Typical Circuit Assembly (Heterodyne Oscillator, 12 to 24 MC Band)*



12-24 M.C.
6-12 M.C.
3-6 M.C.
L105
L106
Z106
C103
140 MMF.
L103
L104
Z105
C102
140 MMF.
L101
L102
Z104
C101
140 MMF.
L109
L108
L107
EGI
.01 MFD. C106
.002 MFD. C105
.002 MFD. C104
FIXED
A.G.C.
S101
AGC.
.002 MFD. C204
+125 V.
+6.3 V.
-14 V.
1ST. R-F V103 RCA 36
2ND. R-F V106 RCA 36
3RD. R-F V109 RCA 36
V102
V101
V105
V104
V108
V107
.01 MFD. C109
.01 MFD. C110
.01 MFD. C107
.01 MFD. C108
C113 .001 MFD.
C112 .01 MFD.
C111 .01 MFD.
L112
L111
L110
1MFD. C114
C120 .01 MFD.
C119 .01 MFD.
C118 .01 MFD.
L115
L114
L113
Z109
Z108
Z107
140 MMF. C117
140 MMF. C116
140 MMF. C115
.001 MFD. C123
.001 MFD. C122
.001 MFD. C121
L118
L117
L116
L122
L124
L123
L125
L121
L120
L119
C126 .002 MFD.
C125 .002 MFD.
C124 .002 MFD.
R103 2 MEG.
R102 30,000Ω
R101 25,000Ω
1MFD. C203
1,000Ω R123
10,000Ω R122
C129 .001 MFD.
C128 .01 MFD.
C127 .01 MFD.
L128
L127
L126
.01 MFD. C202
L177
.01 MFD. C201
L176
C132 .01 MFD.
C131 .01 MFD.
C130 .01 MFD.
L131
L130
L129
Z112
Z111
Z110
140 MMF. C135
140 MMF. C134
140 MMF. C133
.001 MFD. C138
.001 MFD. C137
.001 MFD. C136
L134
L133
L132
L137
L136
L135
C141 .002 MFD.
C140 .002 MFD.
C139 .002 MFD.
R106 2 MEG.
R105 30,000Ω
R104 25,000Ω
.01 MFD. C143
.01 MFD. C142
.001 MFD. C146
.01 MFD. C145
.01 MFD. C144
L140
L139
L138
S102
L143
L142
L141
Z115
Z114
Z113
C149
C148
C147
140 MMF.


T-6017


+125 V.
+6.3 V.
-14 V.
L177
L176
.01 MFD. C202
.01 MFD. C201
S102
1,000 Ω R123
10,000 Ω R122
1 MFD. C203
1 MFD. C114
1,000 Ω R113
150 Ω R114
7,000 Ω R115
R116 3,000 Ω
1 MFD. C160
1 MFD. C161
.01 MFD. C159
L151
L150
Z107
Z108
Z109
Z110
Z111
Z112
Z113
Z114
Z115
V104
V105
V107
V108
V110
V111
2ND. R-F V106 RCA 36
3RD. R-F V109 RCA 36
DETECTOR V112 RCA 78
140 MMF. C115
140 MMF. C116
140 MMF. C117
140 MMF. C133
140 MMF. C134
140 MMF. C135
140 MMF C147
140 MMF. C148
140 MMF. C149
.001 MFD. C121
.001 MFD. C122
.001 MFD. C123
.001 MFD. C136
.001 MFD. C137
.001 MFD. C138
.001 MFD. C153
.001 MFD. C154
.001 MFD. C155
R101 25,000 Ω
R102 30,000 Ω
R103 2 MEG.
R104 25,000 Ω
R105 30,000 Ω
R106 2 MEG.
R107 25,000 Ω
R108 30,000 Ω
R109 2 MEG.
R110 100,000 Ω
R111 100,000 Ω
R112 100,000 Ω
.0001 MFD. C169
.0001 MFD. C170
.0001 MFD. C171
.01 MFD. C118
.01 MFD. C119
.01 MFD. C120
.01 MFD. C127
C128 .01 MFD.
.001 MFD. C129
.01 MFD. C130
.01 MFD. C131
.01 MFD. C132
.002 MFD. C124
.002 MFD. C125
.002 MFD. C126
.002 MFD. C139
.002 MFD. C140
.002 MFD. C141
.01 MFD. C142
.01 MFD. C143
.01 MFD. C144
.01 MFD. C145
.001 MFD. C146
.01 MFD. C150
.01 MFD. C151
.01 MFD. C152
.01 MFD. C156
.01 MFD. C157
.01 MFD. C158
.01 MFD. C163
.01 MFD. C164
.01 MFD. C165
.01 MFD. C166
.01 MFD. C167
.01 MFD. C168
.01 MFD. C162
L113
L114
L115
L116
L117
L118
L119
L120
L121
L122
L123
L124
L125
L126
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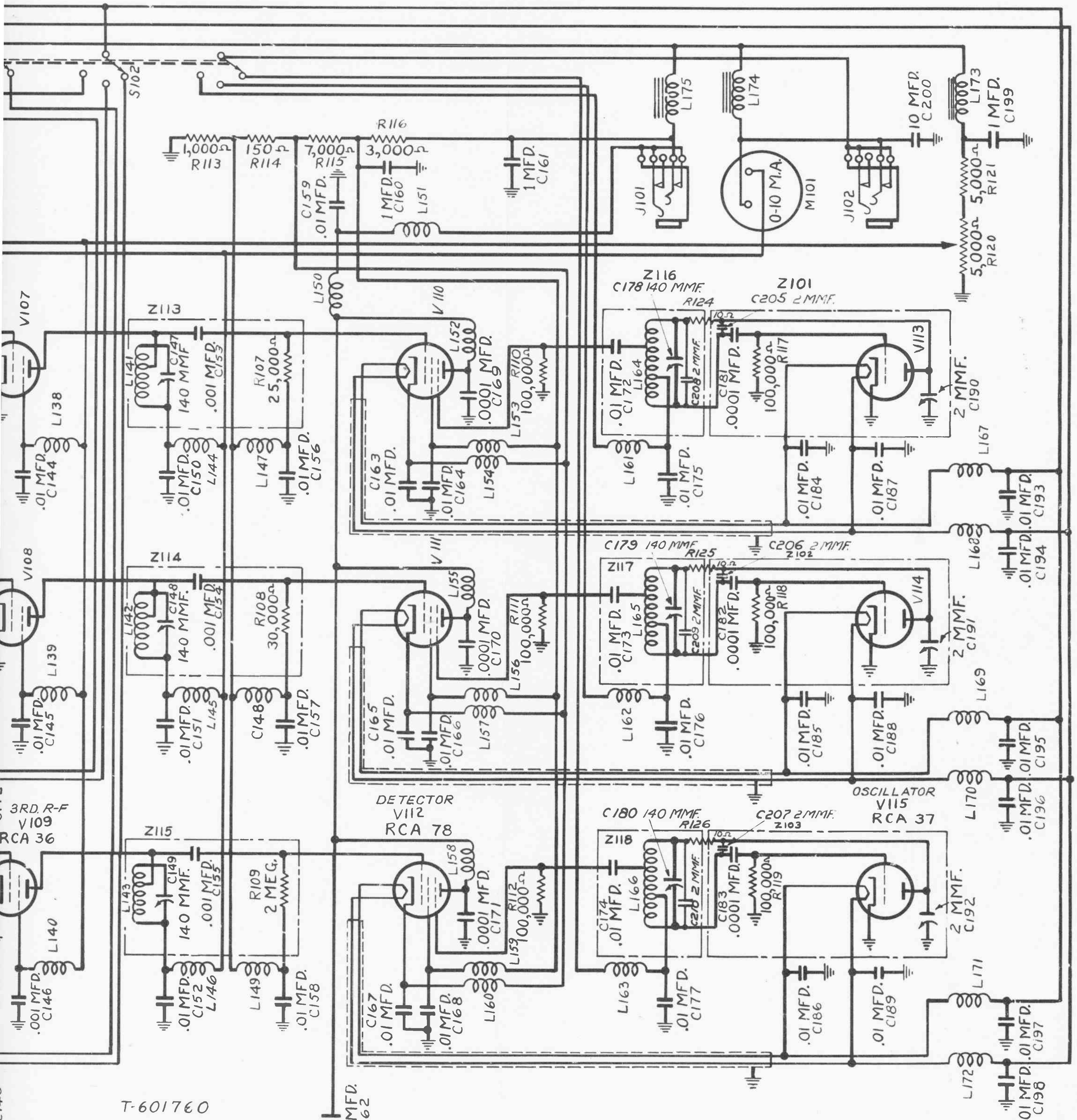
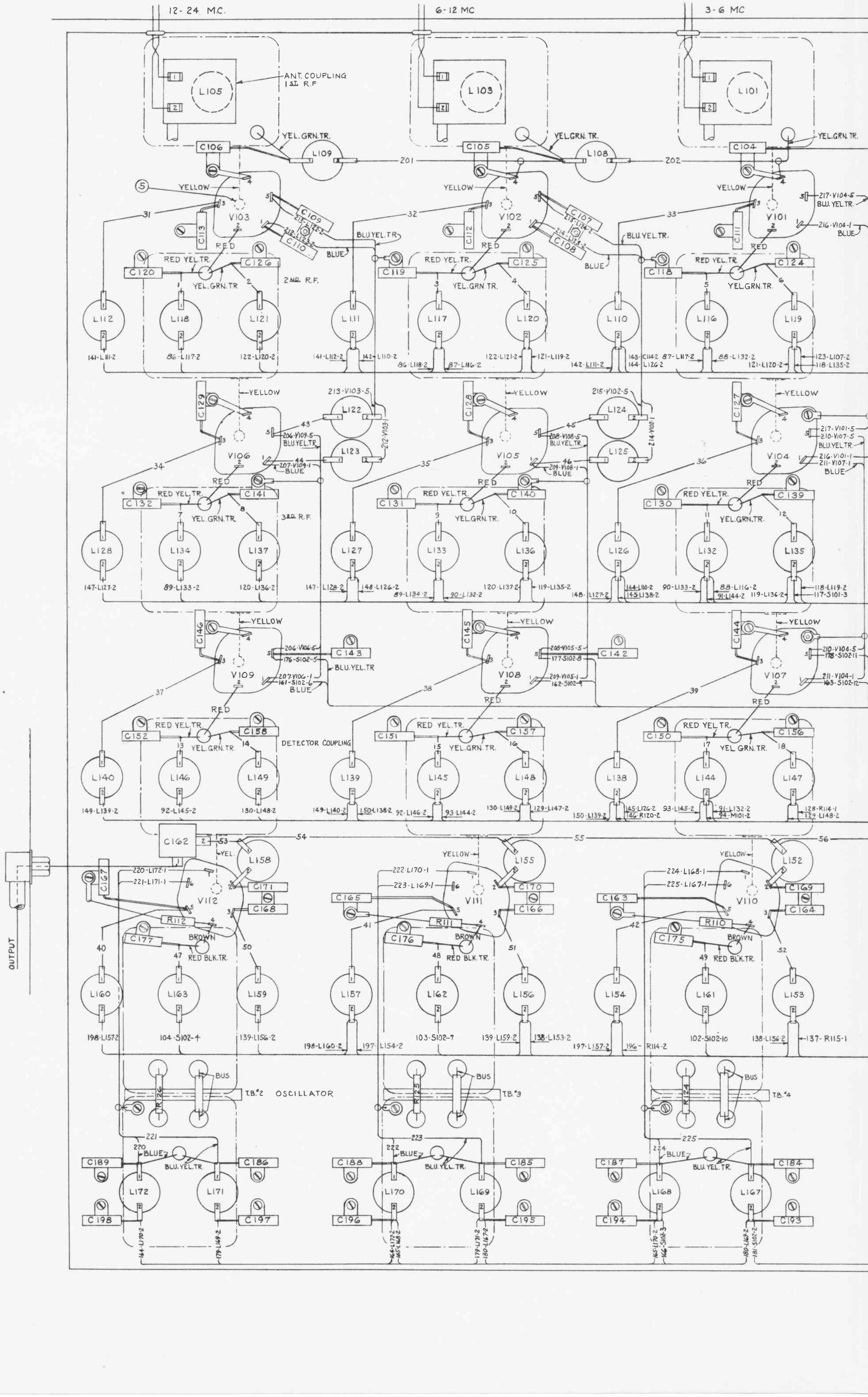
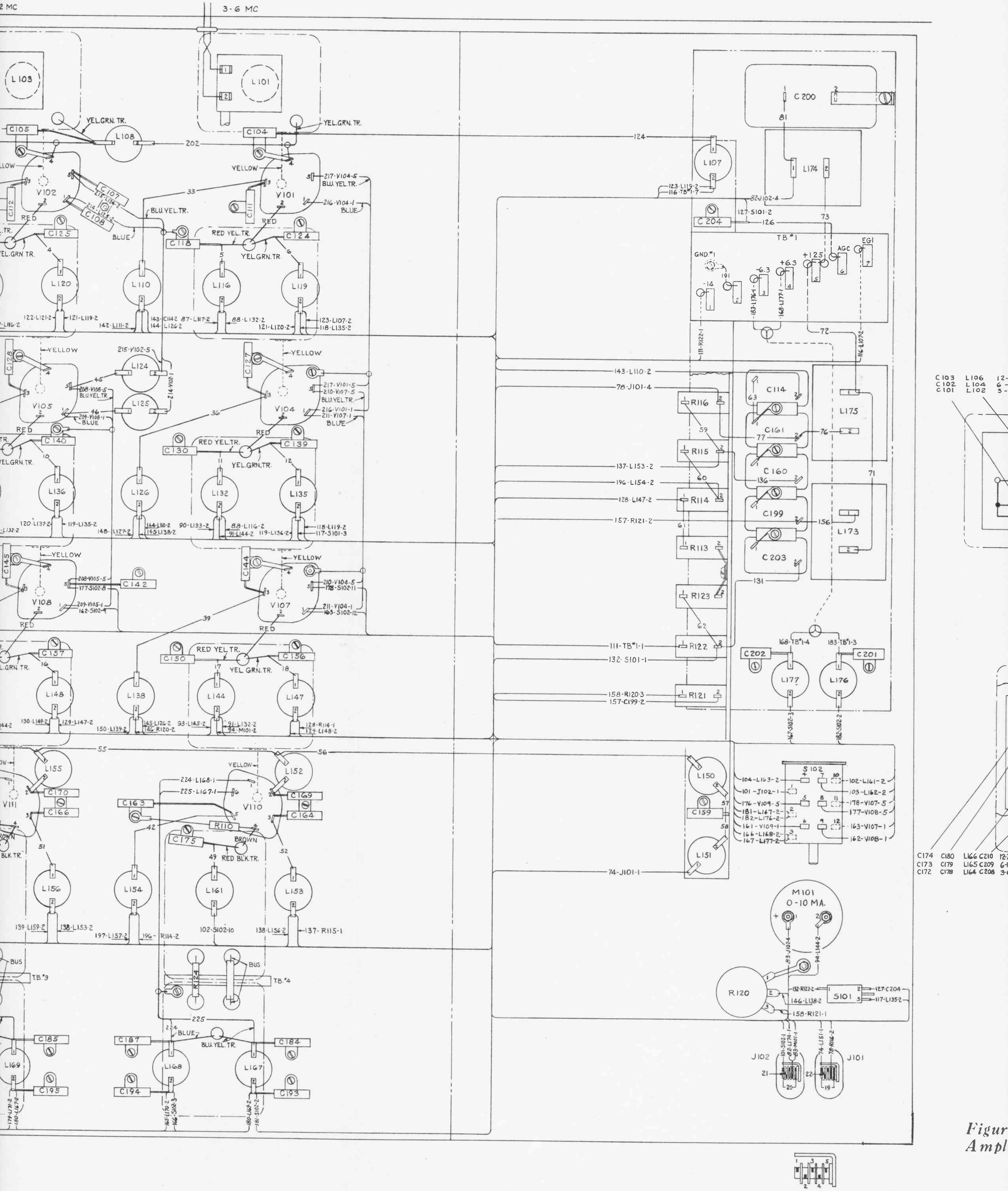
L128
L129
L130
L131
L132
L133
L134
L135
L136
L137
L138
L139
L140
L141
L142
L143
L144
L145
L146
L147
C148
L149
L152
L153
L154
L155
L156
L157
L158
L159
L160
T-601760
OUTPUT
NOTE:- SYMBOL
ARE NOT FOR




NOTE:- SYMBOLS WITH PREFIX "Z" FOR TUNABLE ASSEMBLIES ARE NOT FOR COMMERCIAL APPLICATIONS.

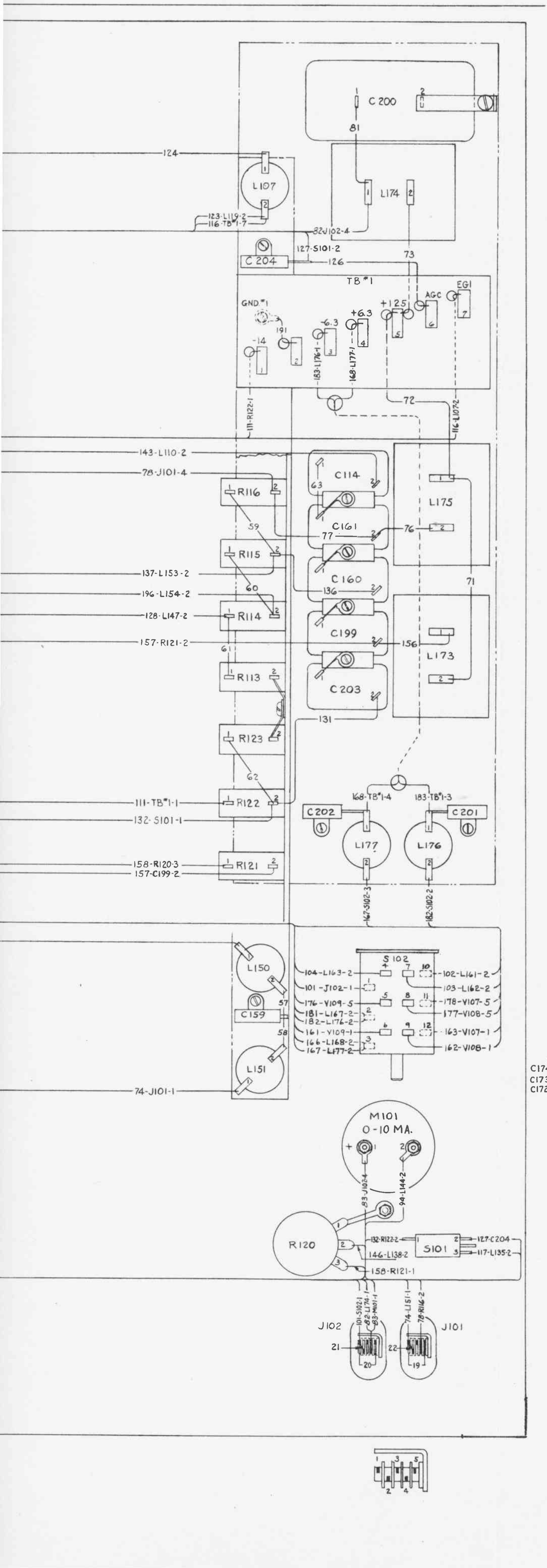
*Figure 7—Type CRV-50096 Radio-Frequency Amplifier Unit (Schematic, T-601760—Sub. 5)*


12-24 MC.
6-12 MC
3-6 MC
ANT. COUPLING 1ST. R.F.
L105
L103
L101
YEL. GRN. TR.
L109
L108
201
202
C106
C105
C104
YELLOW
V103
V102
V101
BLU. YEL. TR.
BLUE
RED
RED YEL. TR.
YEL. GRN. TR.
2ND. R.F.
C120
C126
C119
C125
C118
C124
L112
L118
L121
L111
L117
L120
L110
L116
L119
V106
V105
V104
L122
L123
L124
L125
3RD. R.F.
C132
C141
C131
C140
C130
C139
L128
L134
L137
L127
L133
L136
L126
L132
L135
V109
V108
V107
C143
C142
DETECTOR COUPLING
C152
C158
C151
C157
C150
C156
L140
L146
L149
L139
L145
L148
L138
L144
L147
C162
L158
L155
L152
V112
V111
V110
C171
C168
C170
C166
C169
C164
C167
C165
C163
R112
R111
R110
C177
C176
C175
BROWN
RED BLK. TR.
L160
L163
L159
L157
L162
L156
L154
L161
L153
OUTPUT
BUS
T.B. #2 OSCILLATOR
T.B. #3
T.B. #4
R126
R125
R124
BLUE
BLU. YEL. TR.
C189
C186
C188
C185
C187
C184
L172
L171
L170
L169
L168
L167
C198
C197
C196
C195
C194
C193



3-6 MC
L103
L101
C105
C104
YEL.GRN.TR.
L108
V102
V101
C107
C108
C112
C111
C125
C124
C118
BLU.YEL.TR.
RED YEL.TR.
YEL.GRN.TR.
YELLOW
BLUE
RED
L120
L110
L116
L119
L124
L125
V105
V104
C128
C127
C140
C130
C139
L136
L126
L132
L135
C145
C144
C142
V108
V107
C157
C150
C156
L148
L138
L144
L147
L155
L152
V111
V110
C170
C166
C163
C169
C164
R110
C175
BROWN
RED BLK.TR.
L156
L154
L161
L153
BUS
T.B.#3
T.B.#4
R124
C185
C187
C184
BLU.YEL.TR.
L169
L168
L167
C195
C194
C193
C200
L107
L174
C204
TB #1
GND #1
AGC
EGI
R116
R115
R114
R113
R123
R122
R121
C114
C161
C160
C199
C203
L175
L173
C202
C201
L177
L176
L150
L151
C159
S102
M101
0-10 MA.
R120
S101
J102
J101
C103 L106
C102 L104
C101 L102
C174 C180 L166 C210
C173 C179 L165 C209
C172 C178 L164 C208


*Figur*
*Ampl*




| WIRE DESIGNATION | | |
|---|---|---|
| PART NO. | WIRE NO. | DESCRIPTION |
| 6 | 1 TO 22 INCL. | .032 DIA. BUS P.S.105 |
| 7 | 31 TO 66 INCL. | .0508 DIA. BUS P.S.105 |
| 8 | 71 TO 74 INCL. | RED |
| 9 | 76 TO 78 INCL. | RED YELLOW TR. |
| 10 | 81 TO 83 INCL. | RED GREEN TR. |
| 11 | 86 TO 94 INCL. | RED BLUE TR. |
| 12 | 101 TO 104 INCL. | RED BLACK TR. |
| 13 | 111 | YELLOW |
| 14 | 116 TO 124 INCL. | YELLOW GREEN TR. |
| 15 | 126 TO 130 INCL. | YELLOW BLUE TR. |
| 16 | 131 & 132 | YELLOW BLACK TR. |
| 17 | 136 TO 139 INCL. | GREEN RED TR. |
| 18 | 141 TO 150 INCL. | GREEN YELLOW TR. |
| 19 | 156 TO 158 INCL. | GREEN BLACK TR. |
| 20 | 161 TO 168 INCL. | BLUE |
| 21 | 176 TO 183 INCL. | BLUE YELLOW TR. |
| 22 | 191 | BLACK |
| 23 | 196 TO 198 INCL. | WHITE |
| 24 | 201 & 202 | YEL. GRN. TR. SHIELDED |
| 25 | 206 TO 217 INCL. | BLUE YEL.TR. SHIELDED |
| 26 | 220 TO 225 INCL. | BLUE YEL.TR. SHIELDED |

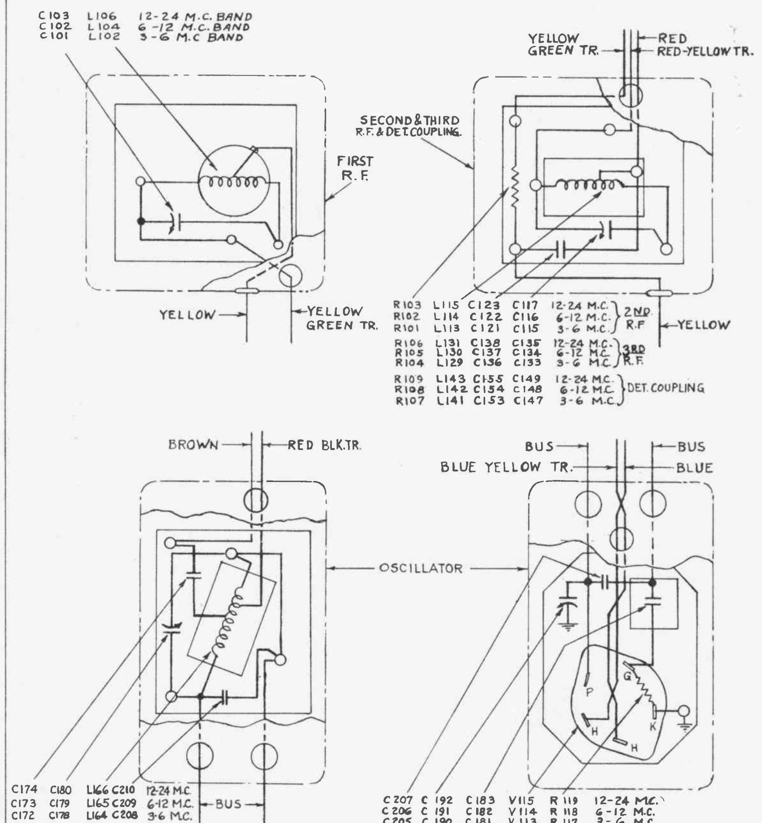



*Figure 8—Type CRV-50096 Radio-Frequency Amplifier Unit (Connections, W-305722—Sub. 2)*