LPB® FAXMAIL

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FROM: JIM QUAY	PAGE 1 OF 10 PAGES

Manufacturers and Distributors of Broadcast Equipment Since 1960

INSTRUCTION MANUAL

RC-25B TRANSMITTER

1.0 INTRODUCTION

The RC-25B is a 20 watt output AM broadcast band transmitter. The unit is rugged, self-contained and proved by the use of well over 500 in the field over the past several years of evolution to the present reliable configuration. The 52Ω standard output impedance is provided at a conventional SO-239 RF connector. The audio input is designed to operate from a conventional 600Ω balanced audio line operating at not in excess of +8dbm. The transmitter is crystal controlled.

2.0 GUARANTEE

Upon receipt of this equipment, we *guarantee* that you will find the appearance, workmanship and standards of material and construction in keeping with the application and with good standards of commercial practice.

For a period of *one year* from date of delivery, we *guarantee* this equipment against *any form of failure,* provided that, in the opinion of the manufacturer, no improper use of or modification to this equipment is at fault. The validity of this guarantee also *requires* that this transmitter be matched into your AC power distribution system using only couplers and/or power splitters *of our manufacture* because of the many failures and cases of poor performance which have resulted from the use of other couplers and splitters. During this period, we will furnish materials and prompt labor in our shops to correct any failure.

If need for service arises, *CONTACT THE MANUFACTURER* for permission to return and for shipping instructions *BEFORE shipping.* Note that shipping charges are not covered. Note also that we will *assume no responsibility* for corrective action for shipping damages as a result of parcel post or REA express shipping when you fail to heed these instructions.

Prompt delivery of replacement parts, tubes, crystals, etc., is always available for out-of-warranty equipment, as are repairs at very nominal cost.

WARNING!

Radiation from this equipment is regulated by Part 15 of the Rules and Regulations of the Federal Communications Commission, *and they are enforced!* Applicable excerpts from Part 15 are found later in this manual. Many stations have been closed down for excessive radiation, yet there is no need for this in a properly designed system.

The services and experience of Low Power Broadcast engineers are always available to customers for assistance in the proper application of this and related equipment.

3.0 DESCRIPTION OF TRANSMITTER CIRCUIT

Consult the following schematic diagram for circuit details. Voltages indicated in brackets are typical DC values as measured with a vacuum tube voltmeter of at least 10 megohms input resistance and with the transmitter tuned and operating into a 52Ω dummy load. Numbers appearing beside tube elements are pin numbers on the socket, and colors of transformer leads are shown.

3.1 RF SECTION DESCRIPTION

3.1.1 Oscillator and Buffer Amplifier

The crystal controlled Pierce-type oscillator employs the pentode section of a 6AL11 tube. This circuit will operate over a wide range of crystal frequencies without modification of any circuit values. The tetrode section of the 6AL11 is a tuned buffer amplifier. The fixed capacitor shunting the slug tuned inductor in the plate circuit determines the tuning range of this circuit, and may require changing if the transmitter frequency is to be changed greatly. Tuning to resonance is indicated by maximum brightness of the adjacent neon lamp which is connected across the resonant circuit as an RF voltmeter. Once set, this tuning will require no further adjustment in normal operation, thus the control is found on the chassis rather than the front panel.

3.1.2 RF Power Amplifier

The RF power amplifier of the RC-25B transmitter employs a 7984 tetrode in Class C with fixed negative grid bias. The 7984 is similar to the better-known 6146, but offers the convenience of all connections at the base and displays improved efficiency in the RC-25B application. It was designed for mobile transmitter service, hence is not a stock item with most parts distributors. Note that the 7984 has a 13.5 volt mobile heater, hence requires a separate source of heater voltage.

The pi network used for the output tuning and matching circuit of the 7984 is conventional except for the use of a fixed value of output loading capacitor necessitated by the large value of C needed at these low frequencies. This capacitor, C_3, is of different value for various several hundred kHz segments of the AM broadcast band. The nominal RF output impedance is 52Ω, but the transmitter will accomodate a wide range of loads about this value, including 75Ω, with no modifications.

The power amplifier stage is both plate and screen grid modulated, a requirement to achieve 100 percent modulation.

3.1.3 Output Network Tuning

The pi network input tuning capacitor, with front panel dial control, is a 1,356pf variable capacitor with fixed shunting mica capacitors rated at least 1kv as required at lower operating frequencies. Resonance is indicated by a plate current meter dip. The range of current values which may be expected for acceptable operation of the transmitter are bracketed on the meter scale. Efficient output loading may produce a rather minor dip at resonance, hence is not always immediately obvious when tuning. Proper transmitter loading for high plate current and rated power output is *IMPORTANT* for reliable operation and is discussed in detail in the following sections.

Do not operate the transmitter without a load connected to the output.

3.2 MODULATOR SECTION DESCRIPTION

The 600Ω balanced audio line input from the studio console or distribution amplifier is transformer coupled to push-pull 12AU7A voltage amplifier sections. A modulator gain control is provided on the rear of the chassis and includes a locking nut to prevent accidental movement after the setting has been made. The push-pull voltage amplifiers drive Class AB_1 push-pull 6CA7/EL-34 tubes operating with fixed bias. Modulator output is coupled to the RF power amplifier via the modulation transformer. Maximum audio input level to prevent damage to the audio line input transformer is +8dbm, which is the standard maximum line level allowed in the telephone industry to avoid crosstalk.

3.3 POWER SUPPLY SECTION

Input power for the RC-25B transmitter is 117v AC 50/60 Hz, approximately 200 watts. A 3-wire line cord with internal grounding pin is furnished. Operation with the removal of this power cord grounding pin is considered both *unsafe* and an *unathorized modification*. The 3 amp type AGC fuse is located under the chassis, with access by removal of the top and bottom cabinet sections. *Do not use a slow-blow fuse.*

The high voltage power supply is a conventional silicon rectifier bridge and choke input filter. The 0.1mfd capacitor at the input to the filter network is a voltage transient protection device. The power transformer contains 6.3v and 13.5v tube heater windings and a fourth winding for the half-wave silicon rectifier bias supply.

4.0 OPERATION OF THE TRANSMITTER

Your RC-25B transmitter has been fully inspected and tested with the same tubes and crystal you receive prior to shipment from the factory. A final inspection sheet is enclosed which gives the check-out operation values which you can use for reference when checking the transmitter performance at any later date.

If the transmitter is received with *any damages* notify both the shipper and Low Power Broadcast immediately as instructed on the packing sheet. If the operating performance into a dummy load is not as our final inspection sheet, notify us immediately.

TO OPERATE THE TRANSMITTER, proceed as follows:

a. Connect a 52Ω dummy load to the RF output connector. *Note* that conventional resistors *are not resistive* at broadcast frequencies, hence *are not acceptable* for this application. Typical commercial dummy loads are the Heathkit HN-31 "Cantenna" ($10.95) or the Ohmite D-101-52 ($12.60). The LPB T-4 Dummy Load/Decade Box ($35.00) is a specially designed test device incorporating a dummy load and capacitor decade for convenience in testing and installing the RC-25B transmitter.

b. Inspect the transmitter to see that the crystal and all tubes are in place.

c. Turn the modulator GAIN control on the rear panel to minimum (CCW) position.

d. Plug the line cord into a suitable power outlet and turn the power switch ON.

e. After allowing a two or three minute warm-up period, tune for a plate current dip on the panel meter. Confirm that this value is similar to that shown on the final inspection sheet supplied with this particular RC-25B.

f. The RC-25B transmitter is now ready for connection to an audio line input from the studio console or audio distribution amplifier and to the RF distribution or coupling system. See publications such as the ARRL *Radio Amateur's Handbook* or the IBS *Master Handbook* for a discussion of conventional methods for adjustment of gain for 100 percent modulation of the transmitter carrier output. An adequate initial setting is secured by advancing the GAIN control while feeding a normal level of program material and listening on a nearby receiver for the onset of distortion at volume peaks, then backing down the GAIN control slightly from that setting.

RF coupling and distribution techniques are discussed in the enclosed copy of *Limited Area Broadcasting* and the IBS *Master Handbook*.

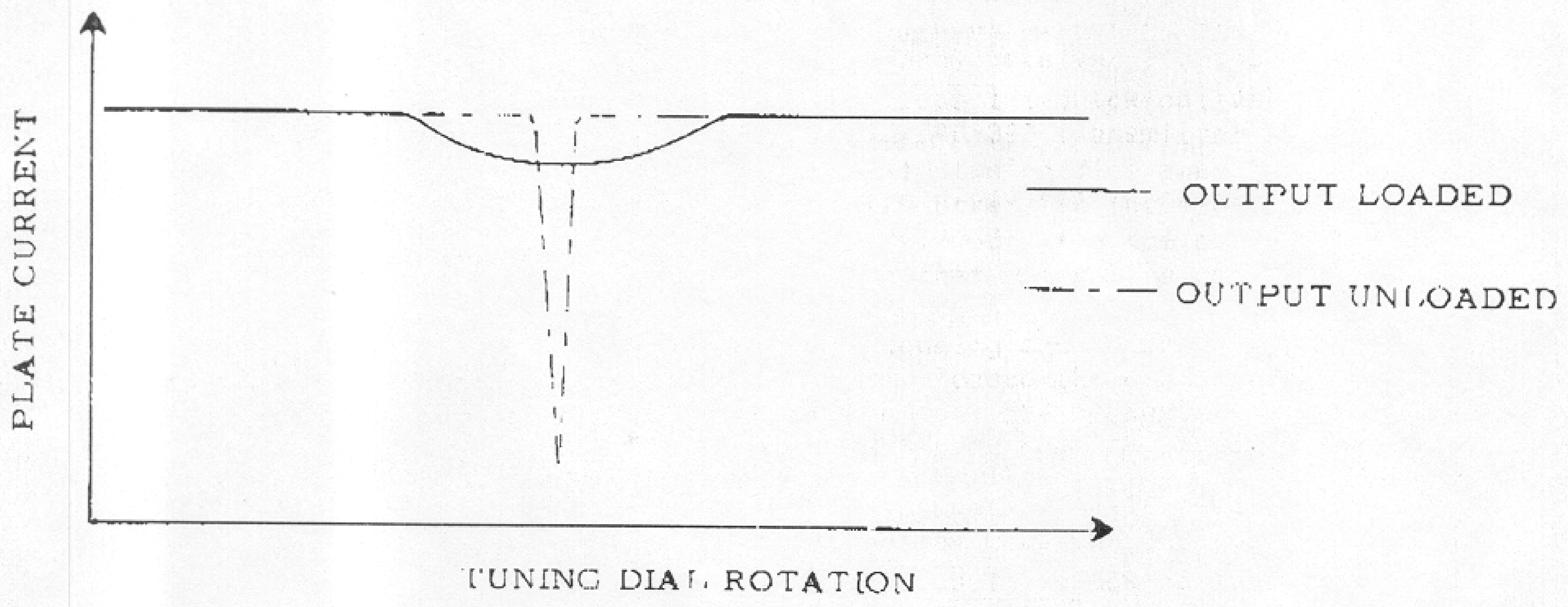
5.0 GOOD OUTPUT COUPLING AND TROUBLESHOOTING

In our experience with over 500 units of the RC-25B, 99% of any and all of your problems in the use of the RC-25B transmitter will be solved *if you heed the following* .....

5.1 PLATE CURRENT DIP DEFINED

The enclosed final inspection report indicates the check-out values of plate current, power output, etc., for your particular RC-25B transmitter. When operating into a 52Ω dummy load and *detuned* (with the plate tuning dial away from the dip toward either end), the RC-25B typically shows a plate current in the 150-160ma range. As you tune for resonance (the plate current dip) you will observe the current drop abruptly from the 150-160ma detuned value to a *DIP* value that *may not be much less*.

The curve below will assist you in understanding and interpreting the plate current dip. Note that when the transmitter is properly loaded the dip at resonance is both broadened and much less pronounced.



A survey of our records shows that 95% of RC-25B transmitters with tuned and properly loaded plate current dips between 117 and 147ma. The plate current meter brackets the 110 to 160ma range as the *Operating Range*. This information on the meter, plus the comments here, combine to tell you that operation outside this range is *NOT NORMAL* and represents *IMPROPER OPERATION* of the transmitter. *BREAKDOWN* is *GUARANTEED* to result from transmitter operation well below 100ma, which value also tells you that you are not getting the power output that you bought. Operation substantially below (25% or more) the final inspection report value says .....

a. You are getting far less power output than you paid for, and,

b. The transmitter is *incorrectly matched to the load.*

5.2 TRANSMITTER OUTPUT CABLES

The number of RC-25B transmitt er failures, with symptoms as described above, traceable directly to an open circuit in the RF output cable is amazing!

> The best equipment in the world is useless if you can't make solid electrical connections to it!

Pomona Electronics and H. H. Smith both make "RF patch cords" in lengths up to five feet of RG-58/U 52Ω coaxial cable with UHF male PL-259 connectors on both ends to connect the RC-25B transmitter output to either an RC-T1A Power Splitter or an RC-T2B Matching & Coupling Unit. They are properly made, hence are worth the rather high price in many cases. You may order them from Low Power Broadcast at the prevailing catalog price, FOB our plant.

5.3 OUTPUT MISMATCH

A day of operation of an RC-25B transmitter at a plate current of 75ma or below *will result in transmitter failure*. Since these pages hand-feed you on how to avoid this, *it's your fault, not ours,* and the symptoms *are unmistakable* to us! If not an open-circuit output cable, the mechanism is as follows:

A transmitter-to-load mismatch bad enough to result in less than 75ma plate current means a high VSWR (Voltage Standing Wave Ratio) seen by the transmitter output. This VSWR is reflected back to the 7984 RF power amplifier tube plate circuit multiplied by about 6.4 (as a result of the impedance matching properties of the pi netowrk).

By way of an example, the properly matched RC-25B puts about 34v RMS carrier into a 52Ω load. A 5:1 VSWR is modest; thus $34 \times 5 \times 6.4 = 1090$v RMS. Put this on top of the 330v DC plate voltage plus the audio modulation peaks, remembering to multiply first by $\sqrt{2}$ to convert to peak AC, and it is no wonder that the 7984 gives up!

If the 7984 internally *shorts,* the excessive plate current will destroy the series 10mhy RF choke and possibly the expensive modulation transformer. If the 7984 *opens,* an even more interesting phenomenon results ..... suddenly unloading the secondary of the modulation transformer means that the swings of audio voltage there will increase greatly; probably enough to puncture the insulation and ruin the modulation transformer. The prospective repair bill and off-the-air time should prove unattractive.

The output load mismatch so unattractively described above results when the AC power distribution system displays a large inductive component at broadcast frequencies.

Read on, for we are getting to the heart of the problem!

The pi network output circuit of the RC-25B has the flexibility to accomodate a wide range of load resistances, but it can accomodate little or no accompanying reactance. The connection of an otherwise perfectly operative RC-25B to an AC power distribution system, via an RC-T2B Matching & Coupling Unit, with a resulting excessive dip of plate current, is a problem of *power system inductance.* This must be cancelled at the source, that is, at the input to the RC-T2B (of which several may be on the output of a single transmitter following a power splitter), using *an appropriate series mica capacitor.*

This capacitor is best inserted in the RC-T2B in series with the center conductor of the SO-239 coaxial input connector.

Determination of the appropriate value of series capacitor required for the particular installation is done by temporarily inserting a mica capacitor decade box in series between the transmitter output and the coupling unit intput. If the installation uses several coupling units, go temporarily to each one with the transmitter and play this game ..... note that no modulation is needed. The decade box approach is far more desirable than the one-by-one insertion of different capacitors, for it shows much more unmistakably the trend of plate current while switching from one value of capacitor to another. You will see the plate current *walk right up the meter scale* as you approach the optimum value. The optimum will not be critical; ±10% will not have a major effect upon plate current. Expect the appropriate value to be between 500pf and 7,000pf.

A capacitor mica decade box of suitable range will usually be found in any electronics lab. The Heathkit IN-27 ($18.95) is a very satisfactory unit to purchase. The new Low Power Broadcast T-4 Dummy Load/Decade Box ($35.00) combines this mica capacitor decade (100pf to 11,000pf at 1kv in 100pf steps) with a dummy load in one unit with the proper connectors and switching to facilitate this testing.

Once the proper value of capacitor has been determined, the selection of the *style* of capacitor is the next but final hurdle. Substantial RF current flows through this capacitor, hence many standard mica capacitors will prove unstable. The clue is, *does the capacitor heat after a few minutes of operation?* It is necessary to find a style which does not internally heat, for this will cause a shift of capacity and of plate current. We can give little guide for what style will not heat, except to say that the physically larger the better. Large "transmitting mica" capacitors are optimum for this application. These will not be found on the shelves of electronic parts distributors, but they are often found in abundance among the parts collections of radio amateurs and experimenters. Some typical and current types are:

Aerovox types 1650L thru 1654L
Aerovox types 1445 thru 1447
Sangamo types F1 thru F3
Cornell-Dubilier series 15
Solar type XQ

If the output of your RC-25B is fed through a power splitter to several matching and coupling units via coaxial cable, take the transmitter directly to the location of each RC-T2B along with the mica capacitor decade box to determine the required capacitor. Temporarily overlook the fact that you will be supplying too much RF power to each of the AC distribution system while these brief tests are being made.

Excessive signal strength may result from this improved matching to the AC power distribution system, for it means optimum transfer of RF energy from the transmitter into the power system. One way of controlling this is by the reduction of the capacity of the coupling capacitors (0.1mfd at 600v) in the RC-T2B Matching & Coupling Unit. Note that sellective capacity changes will modify the RF energy fed to each phase in the case of 3-phase AC systems. This may be extremely advantageous if the building happens to have various phases supplying predominantly various sections, wings or floors. Another power reduction method is to insert a small value of fixed resistance in series with the Neutral connection to the power system. This will change the required value of series capacitor.

Note that cancellation of the AC power distribution system inductive component with the appropriate value of series mica capacitor will result in a substantial *increase* of signal strength *within* the building, and an accompanying substantial *decrease* of signal strength *outside!* One more good reason why it is so necessary and helpful to play this silly game!

5.4 TROUBLESHOOTING PROCEDURES

The entire broadcasting system is a chain of many links, *all operating in series.* The old proverb *a chain is only as strong as the weakest link* applies 100%! When a problem in system operation arises, it therefore follows that you must examine the several links of the chain to isolate the fault. When in doubt, it is important to check *each link* to convince yourself that it *is* or *isn't* the problem.

You *MUST* have the facilities to make basic verification of the final inspection report statements of your transmitter operating parameters whenever any question arises. This should be a periodic procedure to maintain quality and continuity of broadcasting. Most important is the simple procedure of operating the transmitter into a 52Ω dummy load to check RF output and verify the tuning procedure. This *REQUIRES that you have a dummy load.* For instance, if you can't get the transmitter plate current up to a value near that shown on the final inspection report while operating into the AC power system load, the first logical step is to check the transmitter operation against the check-out parameters using a dummy load.

Next, the transmitter plus coax system, any power splitters and the matching and coupling units may be checked as a sub-system by moving the coupling unit impedance matching tap to the 52Ω position and operating the transmitter while driving the RF output power thru the cable, splitters and coupler into the dummy load connected between any one LINE connection and the NEUTRAL connection *in place of* the AC power system load. This is an excellent periodic check-out procedure to perform, and while doing so try shaking all coaxial cable connections.

The modulation performance of the transmitter alone, and then of the transmitter/cable/splitter/cable/coupler sub-system may be checked by applying program material to the transmitter audio input and monitoring the radiation from the dummy load with a receiver located nearby.

Troubleshooting by substitution is another essential procedure. That is, if you have any question about the performance of a component of the system (transmitter, cable, power splitter, coupler, etc.) replace it with another which is operating satisfactorily in another location. This is another reason why *spare equipment is so important.* Every commercial station has a spare back-up transmitter .....why should you be an exception?

5.5 IMPEDANCE MATCHING PROBLEMS

5.5.1 Audio Lines

The studio console has a single 600Ω balanced audio line output, which is just fine to drive a single audio line to one transmitter.

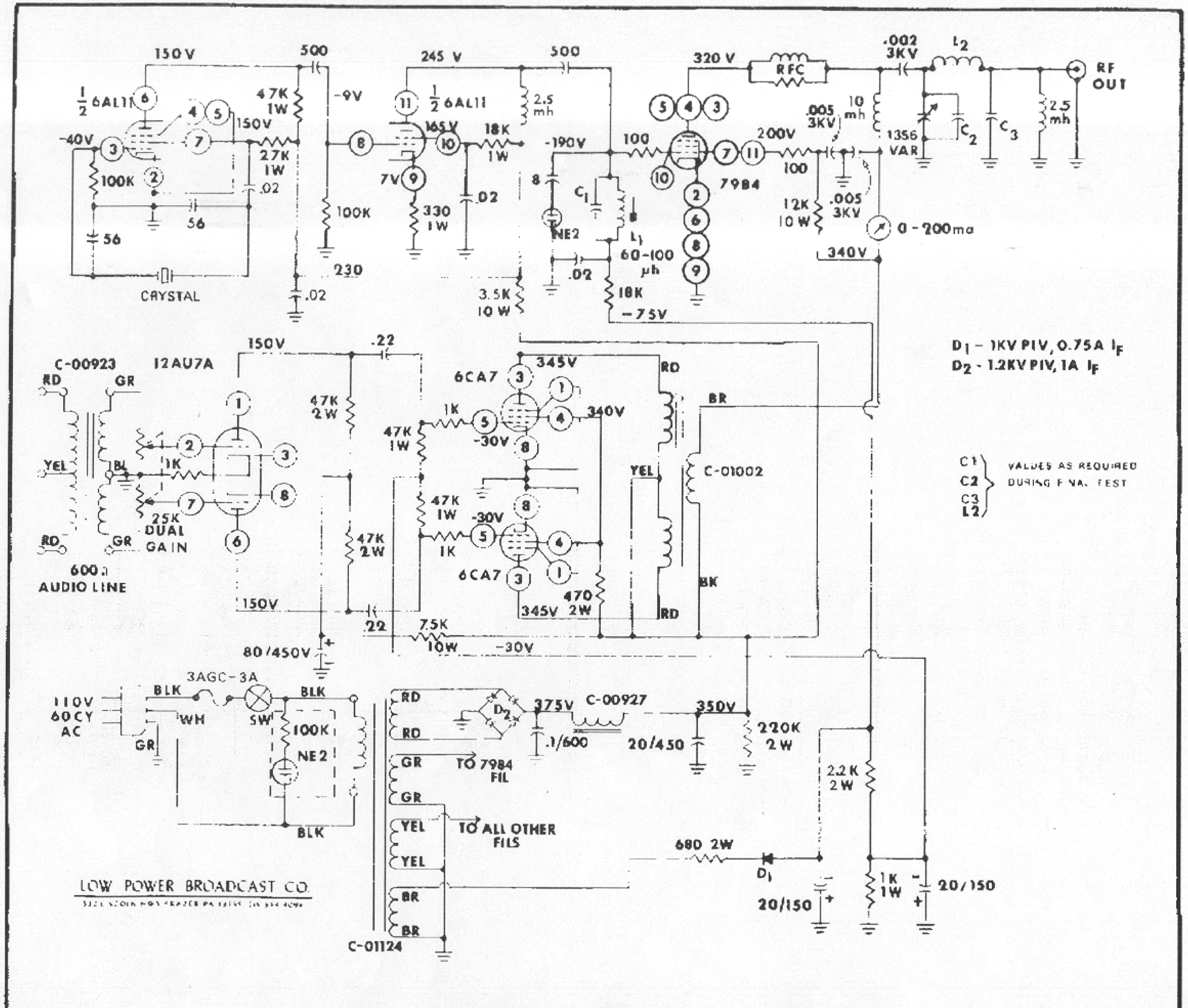
With two audio lines to remotely located transmitters to be driven from a single console output, a UTC A-43 or LS-68 transformer provides the solution by dividing the single console output into two matched outputs. You may now wish for more console output level, however, if you still need to drive the lines at +8dbm.

The requirement to drive three or more audio lines to remote transmitters presents a requirement for additional equipment in the form of an *audio distribution amplifier*. Such a device provides the needed power gain to drive many audio lines, while maintaining electrical isolation between them so that a fault on one line will have little or no effect on the others. The Low Power Broadcast S-1 Audio Distribution Amplifier meets these requirements for the drive of as many as 11 lines at minimum cost.

Local telephone companies (supplying audio lines or "loops") are often known to overcome the need for an audio distribution amplifier by the simple expedient of providing a single branch point from which the single console output goes to all transmitters. This is more accurately described as *an impedance mismatch*, the result of which is *an objectionable lack of highs from the transmitters*. If they have done this to you, *don't blame the transmitters!*

5.5.2 RF Distribution Lines

When it is necessary to branch an RF coaxial cable to form a "Y" to feed RF in two directions, an RC-T1A Power Splitter is called for. The alternative convenient procedure of inserting a coaxial "T" fitting into the line immediately produces a 2:1 impedance mismatch and is *incorrect and unacceptable*. This will result in incorrect transmitter plate current as well as unwanted radiation from the coaxial cable ..... yes, coaxial cable definately *will radiate*, that external shielding jacket does not overcome your errors. For a further discussion of RF distribution considerations, see the IBS *Master Handbook* and the enclosed *Limited Area Broadcasting* brochure.



RC-25B TRANSMITTER SCHEMATIC

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FROM: JIM QUAY	PAGE 6. OF 6 PAGES

25B, C tune-up procedure
(To be used if xmttr frequency is changed or unit appears to be incorrectly tuned)

Initial Set up

(1.) Grid tuning network capacitor (500v, DM-15 may be used) on (L1) (C1 SCHEMATIC)

Grid cap value in pf = $\frac{253}{f^2}$ f in MHz

use 680 pf for 640 KHz

solder cap on inductor (note be careful not to damage inductor)

(2) Select approx value of C1 (pi network input cap) from chart. Use clip-on, connect to pi network C2 (SCHEMATIC) (ACROSS VARIABLE CAPACITOR)

(3) select approx value of C2 from chart (pi network output loading cap) use clip-on, connect to pi network. C3 (SCHEMATIC) (ACROSS TRANSMITTER OUTPUT TERM.)

(4) Select approx value of pi network coil from chart. Note: coil has 36 1/2 turns. Start with at least 2-3 turns more than necessary. Solder input side of coil in place. Use alligator clip to hold other end.

Turn xmttr on. note coincidence, dial position at dip & value of plate I & power out (at dip).

Caution: The r.f. voltage at the input of the pi network can cause r.f. burns.

(cont'd)

254A,C tune-up procedure (cont'd)

C1 controls the position of the dial at dip (more C, lower dial dip) (C2 on SCHEMATIC)

The coincidence is controlled by C1 & the pi coil.

Remove a turn at a time while watching coincidence (note: pi coil is fragile, clip away the plastic at the base of the coil before removing each turn.) As coincidence is approached, change C1's value if necessary to keep dip at 50-60 on dial

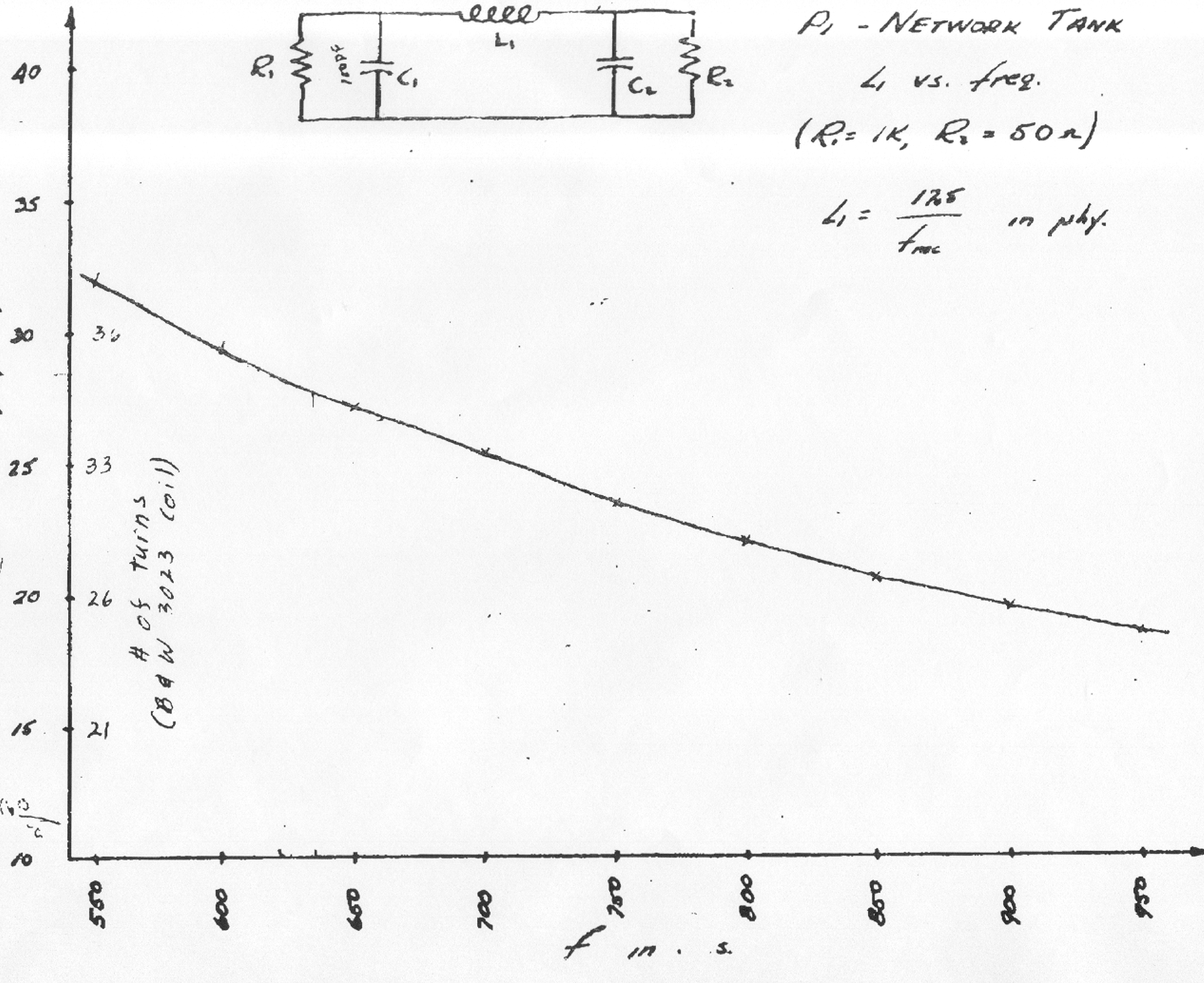
When coincidence is satisfactory, parallel C2 for max. xmttr output.

Recheck:

1. coincidence
2. dial position at dip
3. plate I at dip
4. power output at dip

Solder components in place, modulate xmttr, turn dial looking for instability and capacitor arcing. Let xmttr run for a couple of minutes then feel C1 (carefully) to make sure it is not heating.

If xmttr. freq. has been changed, mark new freq. on S/N tag.



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L1 vs. freq.

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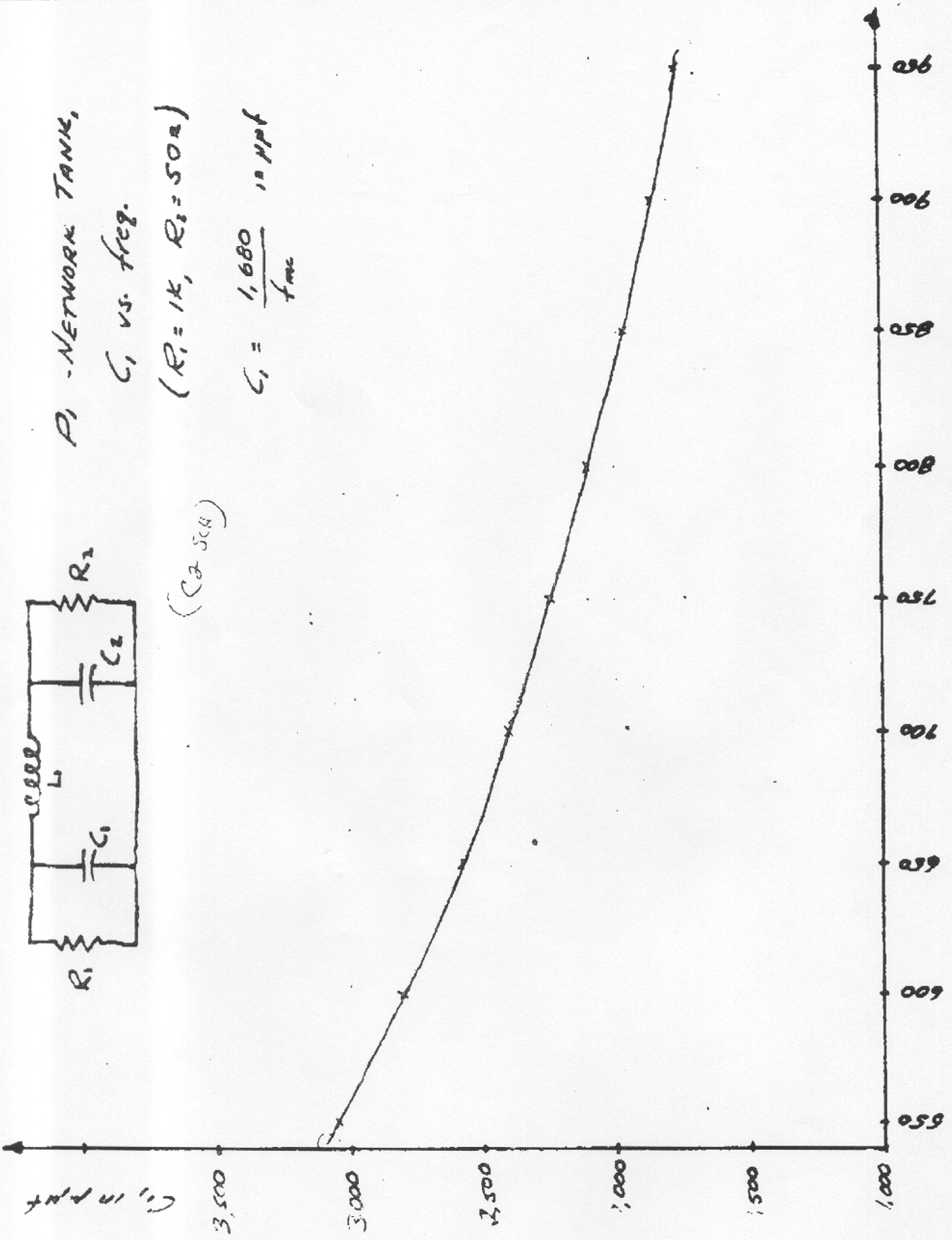

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