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UHF ACTIVE CANCELLATION FILTER

J. A. Hart Jr.

TECHNICAL REPORT NO. RADC-TR-66-10

May 1966

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FOREWORD

This report was prepared by Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia; under Contract Number AF30(602)-3282; Project No. 4540; and Task No. 454003. The RADC project engineer is Wayne E. Woodward, EMCVI-2 This is an interim report covering the period of work from 1 December, 1963 to 1 December, 1965; the originator's report number is 300. A-744.

The work described in this report was performed under the supervision of W. B. Warren, Jr., Project Director, and the general direction of D. W. Robertson, Head, Communications Branch. The work is sponsored by the Vulnerability Reduction Branch of the Rome Air Development Center.

The author of this report is J. A. Hart, Jr. In addition to the author, C. S. Wilson also participated in the work described.

Not releasable to CFSTI:

Numerous new techniques have been devised in designing this active cancellation filter and the Conclusions and Recommendations contain data which will make the filter extremely useful for several different modulation schemes.

This report has been reviewed and is approved.

Approved: Wayne E. Woodward
WAYNE E. WOODWARD
Task Engineer
Interference Analysis & Control Section

Approved: Samuel D. Zaccari
SAMUEL D. ZACCARI, Chief
Vulnerability Reduction Br
Communications Division

ABSTRACT

This report describes a UHF cancellation filter for use over the frequency range 200-400 Mc. The filter can reject CW interference by phase locking an oscillator to the interfering signal and adding the phase-locked signal in such a manner as to produce cancellation of the interference. A superheterodyne system is employed so that interfering signals as low as -80 dbm may be cancelled throughout the 200-400 Mc frequency range. By careful adjustment of the phase and amplitude of the cancellation signal, the interfering signal can be reduced as much as 60 db.

The cancellation filter is designed for use in a 50 Ω system and is inserted between the antenna and receiver. When the cancellation filter is inoperative, the receiving system may be used in a normal manner with the filter remaining in the receiving system.

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1. INTRODUCTION

A serious problem in many communications systems is the presence of an undesired CW signal which is sufficiently large to desensitize a receiver to a desired signal. RF and IF bandpass filters can effectively reduce such interference, but these techniques fail when the CW interference is very close to the frequency of the desired signal and falls inside the passband of these filters. Narrowband rejection filters are sometimes helpful in reducing the desensitization effects of CW interference, but these devices must be retuned when the interference frequency drifts. Because of the limited Q of these devices, distortion of the desired signal is rather severe in some applications.

Many of the disadvantages of these conventional interference rejection techniques can be overcome by the use of an active filter to reject the interfering signal.

An active notch filter has been developed which can be used to reject interfering signals over the frequency range from 200 to 400 Mc. The filter is useful in reducing strong CW interference which is located close to the tuned frequency of a receiver.

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2. DISCUSSION

2.1 Theory of Operation

The active notch filter or cancellation filter described in this report consists of a voltage tunable oscillator which is synchronized to a CW interfering signal. The output of the synchronized oscillator is combined in proper phase and amplitude with the interfering signal to produce cancellation of the interference.

Figure 1 is a block diagram of the cancellation filter. Referring to Figure 1, the signal and interference entering the filter are combined with a cancellation signal in the adder to produce cancellation of the interfering signal, leaving only the desired signal.

The signal and interference also enter a preselector where the interference is partially separated from the desired signal. The output of the preselector is heterodyned to 30 Mc by a local oscillator before entering the phase detector of Figure 1. In a similar fashion, the voltage-controlled cancellation oscillator output is heterodyned to 30 Mc by the same local oscillator, amplified in a 30 Mc IF amplifier, and phase corrected in a variable phase network before entering the phase detector. The local oscillator signals for the two mixers are derived from the common local oscillator through a hybrid junction to prevent signals from the mixer in the upper interfering signal channel from appearing

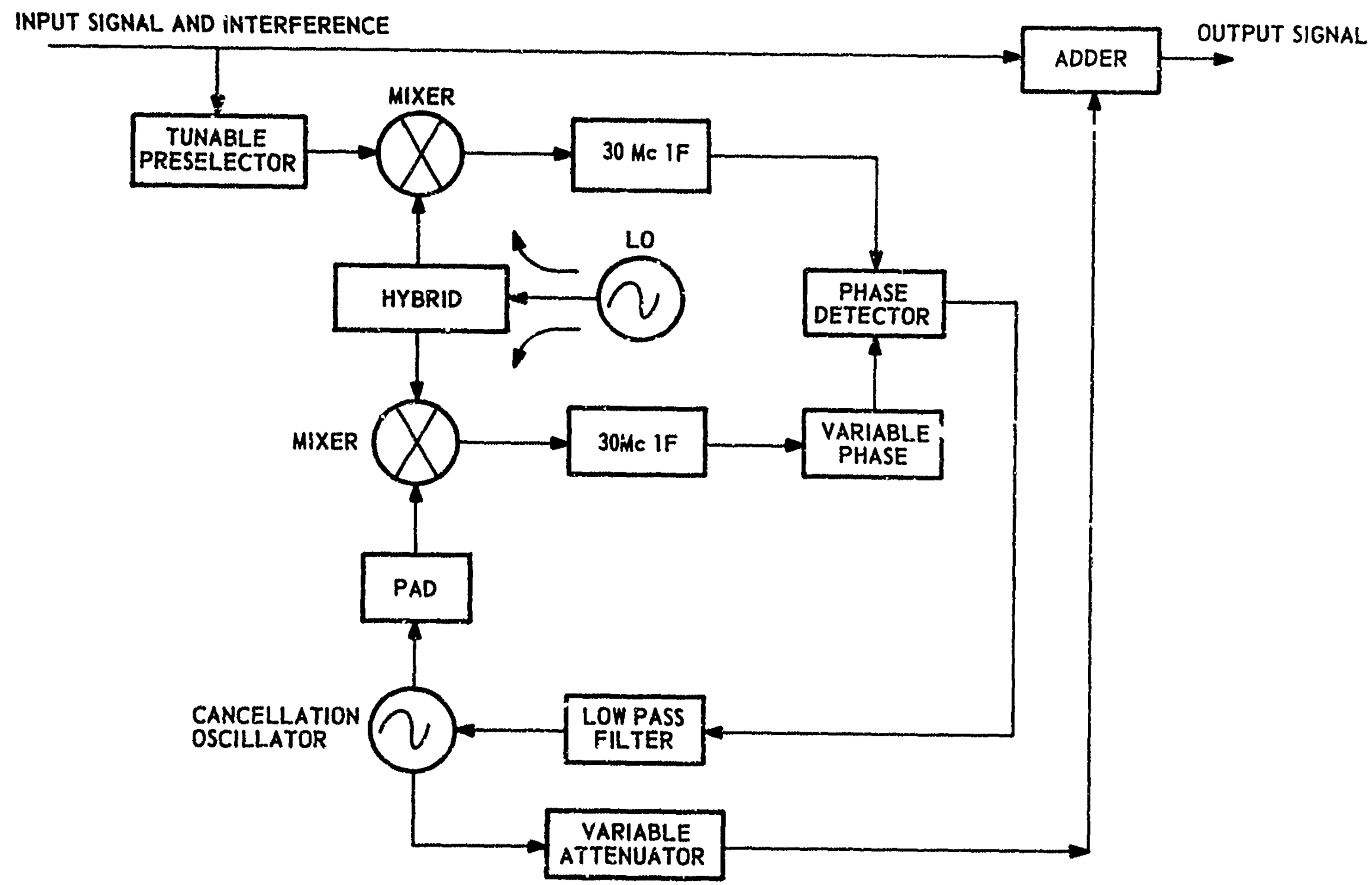

Figure 1. Block Diagram of the Cancellation Filter.

in the lower cancellation signal channel. An attenuator is placed between the mixer and the cancellation oscillator to isolate the cancellation oscillator from the local oscillator feedthrough from the mixer.

The output of the phase detector is a voltage proportional to the cosine of the phase difference between the translated interfering and cancellation signals. The error voltage is low-pass filtered to assure that only the specific interfering signal being cancelled will control the cancellation oscillator. The output of the low-pass filter is applied as a frequency control voltage to the cancellation oscillator to produce a phase-locked condition between the output of the cancellation c `lator and the incoming interfering signal.

2.1.1 Analysis of the Synchronizing Feedback Loop

The following analysis points out the conditions necessary to maintain oscillator synchronization and shows the dependence of the phase angle of the synchronized oscillator output signal on the loop gain and interfering signal amplitude. The translated interfering signal with frequency, ω_i and amplitude, α, can be written as

$$e_i(t) = \alpha \cos(\omega_i t + \theta_i) \quad . \tag{1}$$

The translated cancellation oscillator output of frequency, ω_c, in the lower cancellation signal channel. An attenuator is placed between the mixer and the cancellation oscillator to isolate the cancellation oscillator from the local oscillator feedthrough from the mixer.

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$$e_i(t) = \alpha \cos (\omega_i t + \theta_i) \quad . \tag{1}$$

The translated cancellation oscillator output of frequency, ω_c, and amplitude, β, can be represented by

$$e_c(t) = \beta \cos(\omega_c t + \theta_c) \quad . \tag{2}$$

Because the phase detector can be represented as a multiplier, its output signal can be written as

$$e_d(t) = K_1 \, e_i(t) \, e_c(t) \quad . \tag{3}$$

Substituting (1) and (2) in (3) gives

$$e_d(t) = K_1 \, \alpha \cos(\omega_i t + \theta_i) \, \beta \cos(\omega_c t + \theta_c) \quad . \tag{4}$$

Equation (4) can be expanded in the form

$$\begin{aligned} e_d(t) &= K_1 \, \alpha\beta \cos(\omega_i t + \theta_i) \cos(\omega_c t + \theta_c) \\ &= \frac{1}{2} K_1 \, \alpha\beta \left\{ \cos \left[(\omega_i + \omega_c)t + \theta_i + \theta_c \right] \right. \\ &\quad \left. + \cos \left[(\omega_i - \omega_c)t + \theta_i - \theta_c \right] \right\} \quad . \end{aligned} \tag{5}$$

The factor, K_1, is the gain constant of the phase detector. The sum frequency term in Equation (5) can be dropped since the signal is low-pass filtered. Then the filter output is

$$e_o(t) = \frac{1}{2} K_1 \alpha\beta \cos\left[(\omega_i - \omega_c)t + \theta_i - \theta_c\right] \quad . \tag{6}$$

Now, assuming the frequency of the cancellation oscillator is proportional to the control voltage, the frequency of oscillation of the cancellation oscillator is

$$\omega_c = K_2 \, e_o(t) + \omega_o \quad , \tag{7}$$

where K_2 is a constant relating the control voltage to the frequency deviation of the cancellation oscillator, and ω_o is the natural frequency of the oscillator.

When the cancellation oscillator is synchronized with the interfering signal, ω_c equals ω_i. Substituting (6) in (7) and replacing ω_c in (7) with ω_i gives

$$\omega_i = \omega_o + \frac{1}{2} K_1 K_2 \alpha\beta \cos(\theta_i - \theta_c) \quad , \tag{8}$$

or

$$\cos(\theta_i - \theta_c) = \frac{2(\omega_i - \omega_o)}{K_1 K_2 \alpha\beta} \quad . \tag{9}$$

Equation (9) relates the phase angle between the interfering signal and the local cancellation signal to the loop gain, $K_1 K_2 \alpha\beta/2$, and the difference in frequency between the interfering signal and the natural frequency of the cancellation oscillator.

Once a locked condition between the interfering and local signals has been established, the hold-in range of the loop can be obtained from the fact that

$$\left|\cos\theta\right| \leq 1 \quad , \tag{10}$$

where $\theta = \theta_i - \theta_c$. Hence,

$$\left|\frac{(\omega_i - \omega_o)(2)}{K_1 K_2 \alpha\beta}\right| \leq 1 \quad . \tag{11}$$

At the edge of the hold-in range, the equal sign applies so that

$$(\omega_i - \omega_o) = \frac{K_1 K_2 \alpha\beta}{2} \quad , \tag{12}$$

or

$$(f_1 - f_o) = \frac{K_1 K_2 \alpha\beta}{4\pi} \quad . \tag{13}$$

Equation (13) gives the width of the hold-in range in cycles/sec.

Under normal conditions, the natural frequency, ω_o, of the cancellation signal is set very close to ω_i, so that θ is a small angle near $\pi/2$ or $3\pi/2$. The particular choice of whether the loop settles near $\pi/2$ or $3\pi/2$ depends on which angle corresponds to negative feedback around the loop. The other value of θ then represents positive feedback and as such represents an unstable point. Assuming $\pi/2$ to be the proper choice for the neighborhood of θ, θ may be approximated by

$$\theta \approx \pi/2 - \frac{2(\omega_i - \omega_o)}{K_1 K_2 \alpha\beta} \quad . \tag{14}$$

Equation (14) illustrates that for small $(\omega_i - \omega_o)$ an essentially linear relationship exists between θ and $(\omega_i - \omega_o)$.

2.1.2 Low-Pass Feedback Loop Filter

The stability of the phase-lock loop is dependent upon the gain and the phase shift (or time delay) around the feedback loop.

The phase shift must not exceed 180° around the loop if oscillation is to be avoided. Because 90° of phase shift is inherent in the control of the oscillator frequency with the phase error, less than 90° of phase shift must be maintained in the remaining circuits of the loop to assure stability.

2.2 Equipment Design

The cancellation filter developed operates over the frequency range 200-400 Mc. The 30 Mc IF frequency selected is high enough to provide good image rejection, but still low enough to permit the construction of a high gain, stable IF amplifier.

2.2.1 Local Oscillator

The local oscillator, which was designed to operate over the frequency range 230-430 Mc, is a Colpitts type oscillator with a variable length, shorted transmission line as the inductive reactance of the tuned circuit. Figure 15 includes a schematic diagram of the local oscillator. The equivalent circuit of the oscillator is shown in Figure 2. When the shorted line is connected between the plate and the grid, the Colpitts configuration is formed with the stray capacitance of the tube, and no external capacitance is needed to resonate the reactance of the shorted line.

The output power level of the local oscillator is plotted as a function of frequency in Figure 3.

2.2.2 Cancellation Oscillator

The cancellation oscillator is very similar to the local oscillator except for the addition of the voltage tuning circuitry. Figure 15 includes a schematic diagram of the cancellation oscillator.

The voltage tuning is provided by a back-biased voltage variable, silicon capacitor. The output of the phase detector is connected through an appropriate low-pass filter to the voltage control of the lead oscillator. A negative voltage of approximately 5.5 volts is present across the variable capacitor with no signal applied to the phase detector. When the phase difference between the two 30 Mc IF signals at the input to the phase detector varies, the output voltage of the detector changes the voltage applied to the variable capacitor, and the cancellation oscillator phase is shifted by the proper amount to correct the changing phase between its output signal and the interference.

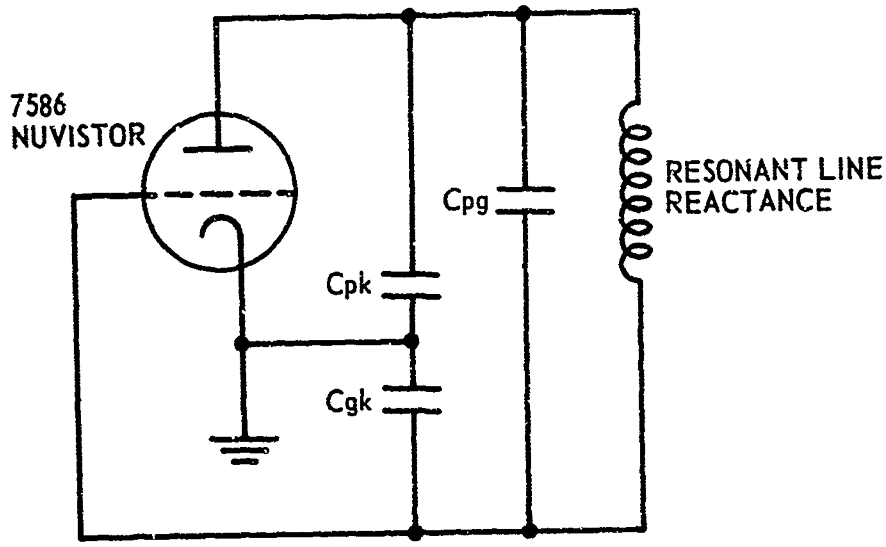


Figure 2. Equivalent Circuit of the Local Oscillator.

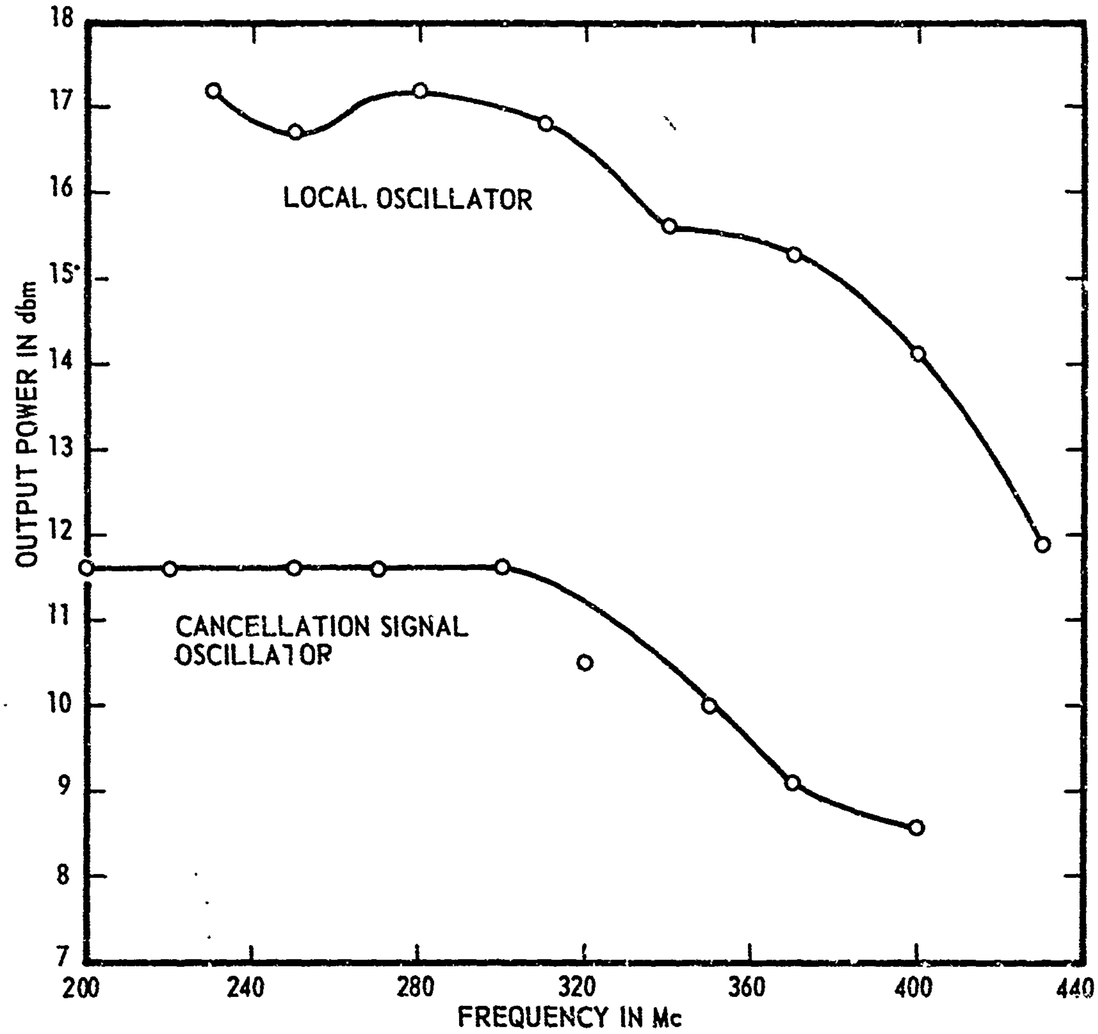


Figure 3. Cancellation and Local Oscillator Output Levels vs. Frequency.

Figure 4 shows a photograph of the cancellation oscillator. The construction of the local oscillator is identical to that of the cancellation oscillator with the exception that no provision is made for voltage control of the frequency. The output power level of the cancellation oscillator is plotted as a function of frequency in Figure 3.

Voltage tuning curves at various frequencies between 200 and 400 Mc are shown in Figure 5, with the frequency deviation being plotted as a function of bias voltage on the variable capacitor. The curves of Figure 5 are sufficiently straight to satisfy the assumption of a linear control characteristic.

2.2.3 Phase Detector

The phase detector module contains both the phase detector and the first two sections of the triple-section, low-pass loop filter shown in the block diagram of Figure 1. The third section of the loop filter is a part of the cancellation oscillator voltage control circuit. Figure 15 includes a schematic diagram of the phase detector. Two buffer amplifiers are included in the phase detector module to isolate the two 30 Mc IF amplifiers. The outputs of the two buffers are added and mixed in a transistor mixer stage which also serves as the phase detector. The output of the mixer is low-passed by an RC filter with a frequency attenuation slope of less than 6 db/octave. Figure 6 shows the attenuation curve of the composite low-pass loop filter. The second

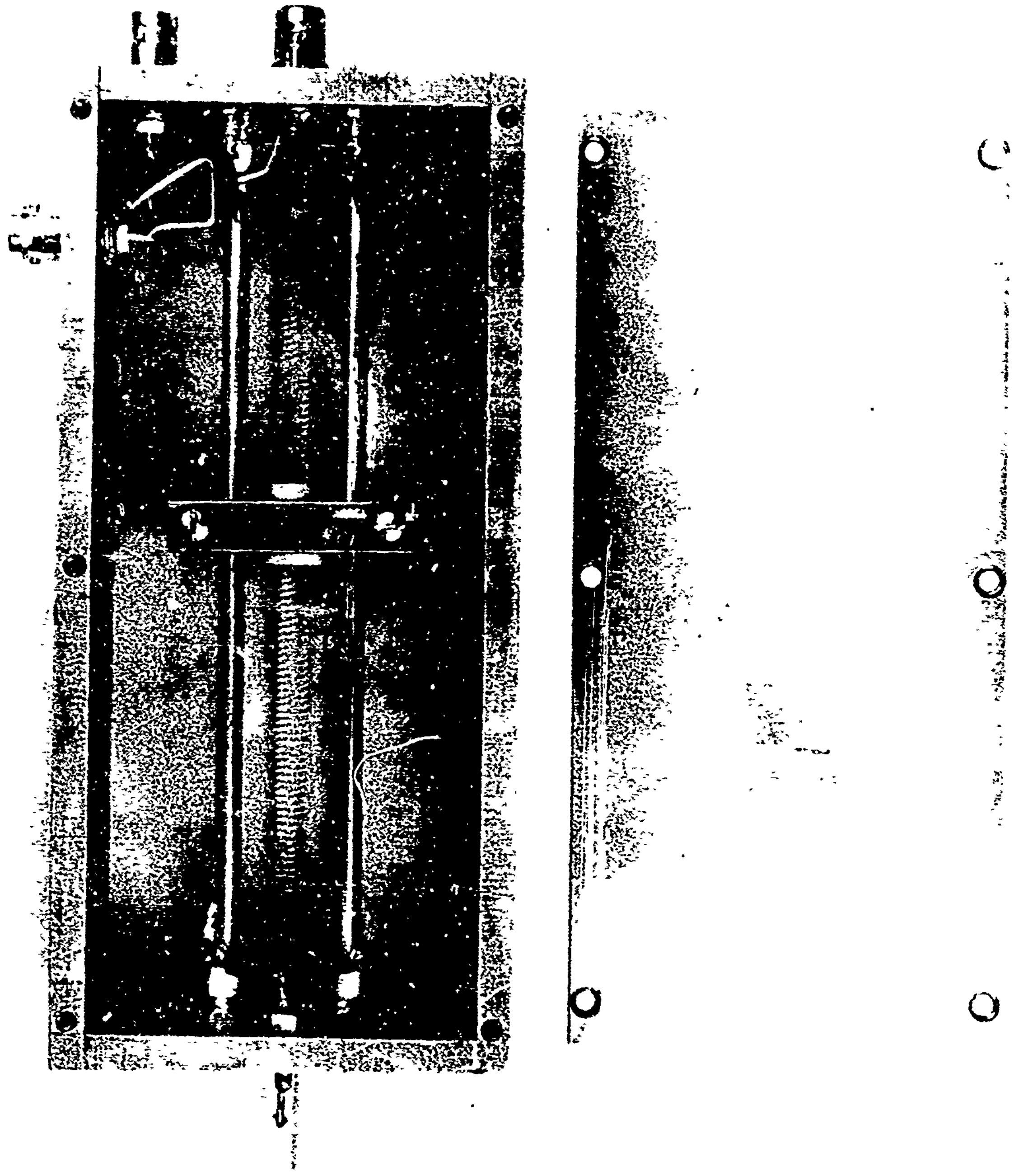


Figure 4. Photograph of Voltage-Controlled Oscillator.

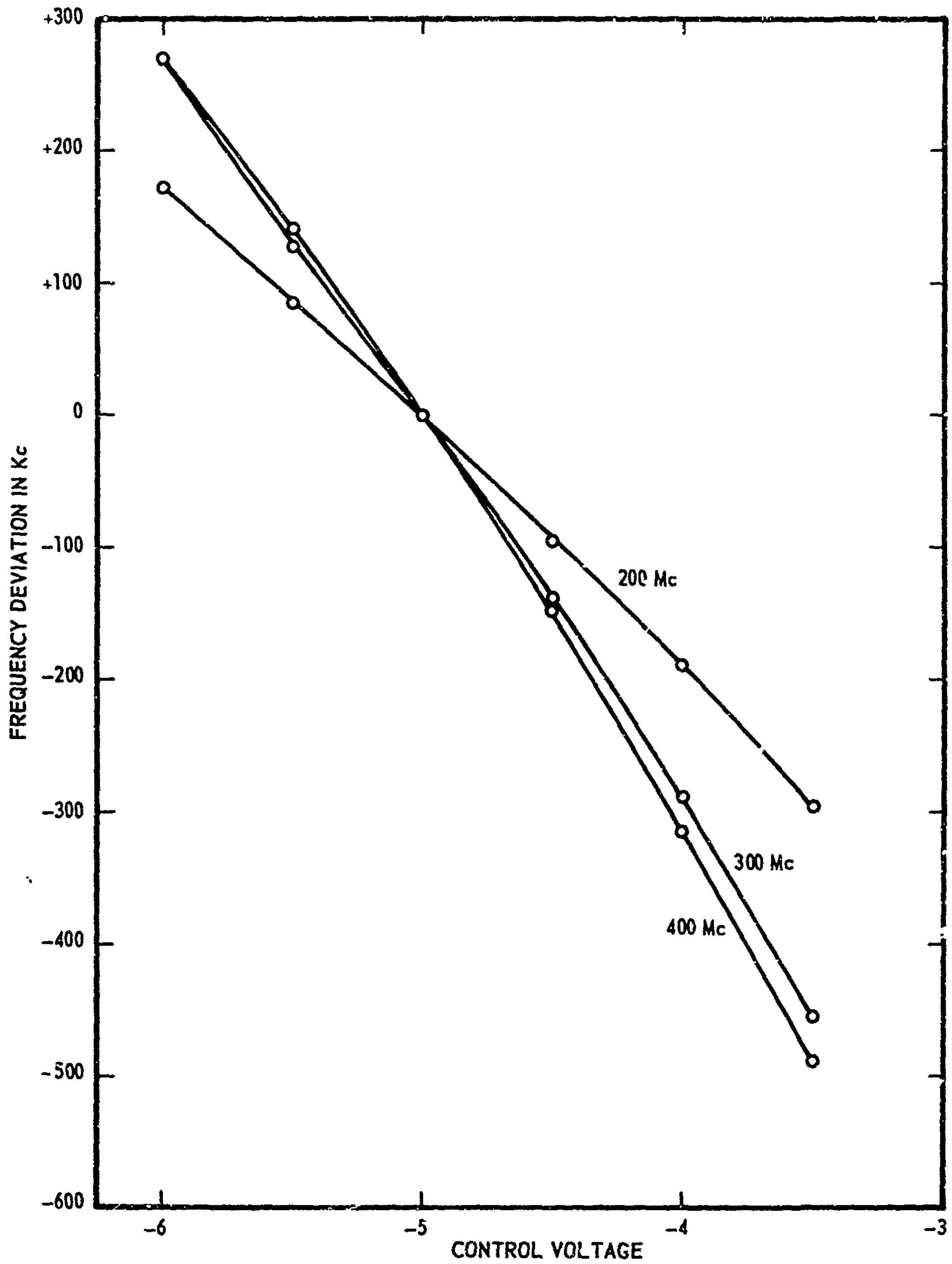


Figure 5. Cancellation Oscillator Frequency vs. Control Voltage.

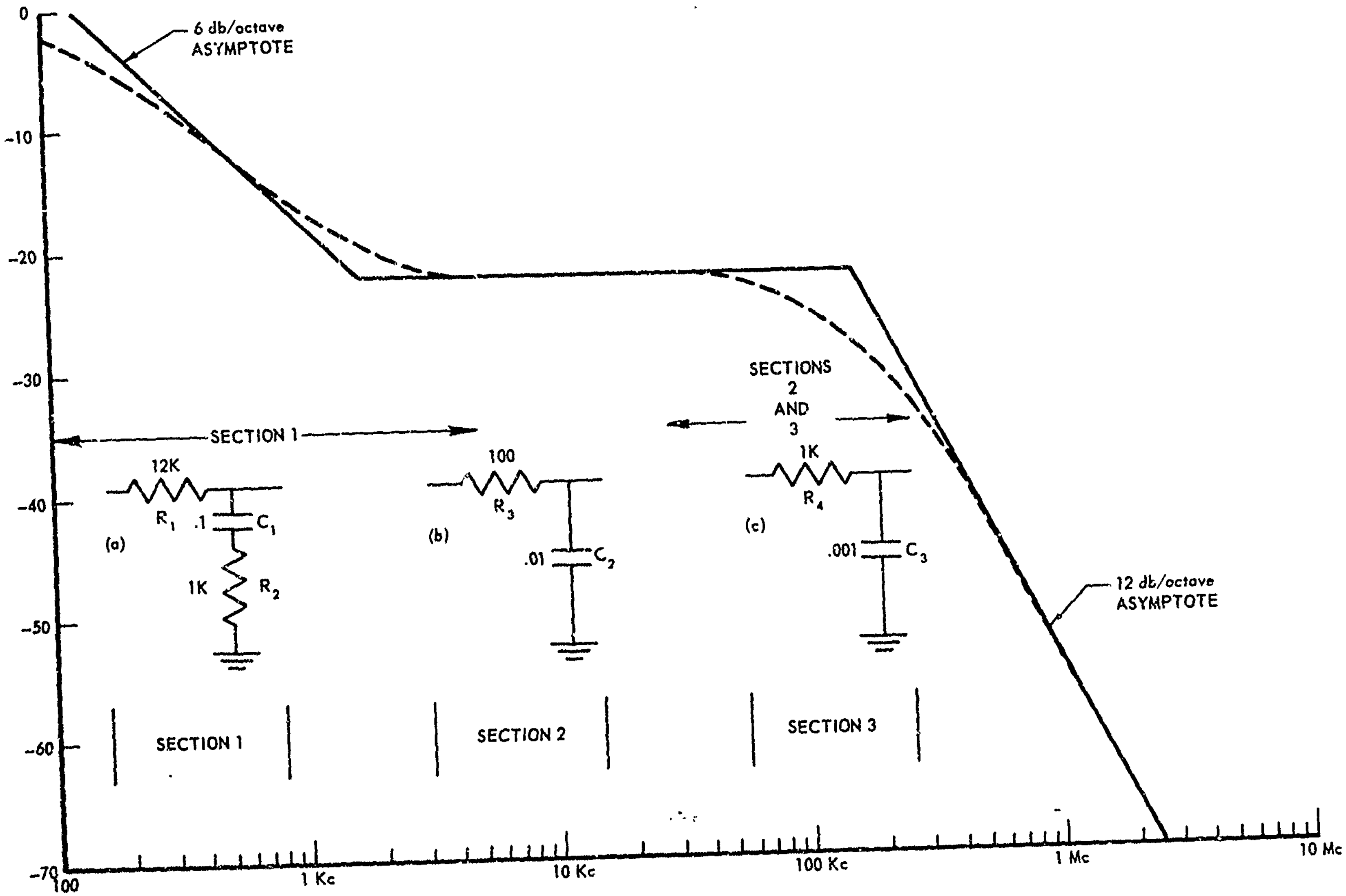


Figure 6. Response of Loop Filter vs. Frequency.

section of the loop filter is isolated from the RC filter by an emitter follower in the phase detector module. The output of the second section is fed into the voltage control circuit of the cancellation oscillator which contains the third and final section of the loop filter.

A low-pass filter such as the one shown as Section 1 of Figure 6, has a phase shift which is less than 90° for all frequencies, i.e., its roll-off attenuation slope is less than 6 db/octave. The phase and gain equations for this filter are

$$\theta = \tan^{-1} \left[\frac{CR_1}{1 + {}^2 C^2 R_2 R_T}\right] , \qquad (15)$$

and

$$|G(j\omega)| = \sqrt{\frac{1 + \omega^2 C^2 R_2^2}{1 + \omega^2 C^2 R_T^2}} , \qquad (16)$$

where θ is the phase shift, $|G(j\omega)|$, is the magnitude of transfer function, and $R_T = R_1 + R_2$.

The two additional sections of RC filtering have 3 db cutoff frequencies well beyond the frequency where the first section has reached its maximum phase shift. The last two sections are used to sharpen the cutoff of the overall filter after the first RC section has reduced the gain sufficiently to eliminate the possibility of oscillation of the loop. Notice that the slope of the attenuation curve does not exceed 6 db/octave until the frequency reaches approximately 160 kc and where the attenuation is approximately 28 db.

2.2.4 Variable Phase Network

The range of phase correction of the cancellation oscillator output needed to cancel an interfering signal may lie anywhere between 0-360°. Because the phase angle of the cancellation signal with respect to the interfering signal is preserved in the translation to the 30 Mc IF frequency, the phase correction is made at 30 Mc to greatly simplify the construction of the phase shifter. Figure 15 includes a schematic of the phase shifter. The variable phase shift is obtained from two stages providing a few degrees less than 360° continuous variation and a switched transformer which provides an additional 180°. A phase variation of approximately 539° is possible with the combination of the continuously variable stages and the switched transformer. The amplitude variation over the entire variable phase range is less than 1.5 db.

2.2.5 Variable Attenuator

A variable UHF attenuator is required to permit adjustment of the cancellation signal to the proper level at the adder where the cancellation and interfering signals are combined. The attenuator used consists of a 50 ohm transmission line shunted with point contact diodes. A potentiometer located on the front panel of the filter varies the amount of DC current in the diodes to provide a range of attenuation of 1 to 65 db over the range 200-400 Mc. The attenuation of the variable attenuator is plotted as a function of the ten-turn potentiometer dial reading in Figure 7. The maximum attenuation requires a total diode current of approximately 85 ma. Figure 15 includes a schematic diagram of the variable attenuator.

2.2.6 Preselector

A tunable preselector was placed between the input to the filter and the signal channel mixer to improve the image rejection of the input mixer and to reduce feedthrough of the local oscillator signal from the input mixer into the filter output. Figure 8 shows a selectivity curve of the preselector at a tuned frequency of 300 Mc. Note that the preselector is not in series with the desired signal path between the input and output of the filter (see Figure 1). Figure 15 includes a schematic of the preselector. A grounded grid amplifier is used to drive the tuned circuit. This amplifier provides both a small amount of gain to overcome the insertion loss of the preselector and approximately 30 db of isolation of the local oscillation feedthrough from plate to cathode. Figure 9 shows the rejection of local oscillator feedthrough as a function of local oscillator frequency, with the preselector tuned to 250 Mc.

The gain of the preselector as a function of the tuned frequency is shown in Figure 10. Over much of the frequency range from 200-400 Mc, the gain is less than unity. This low gain is

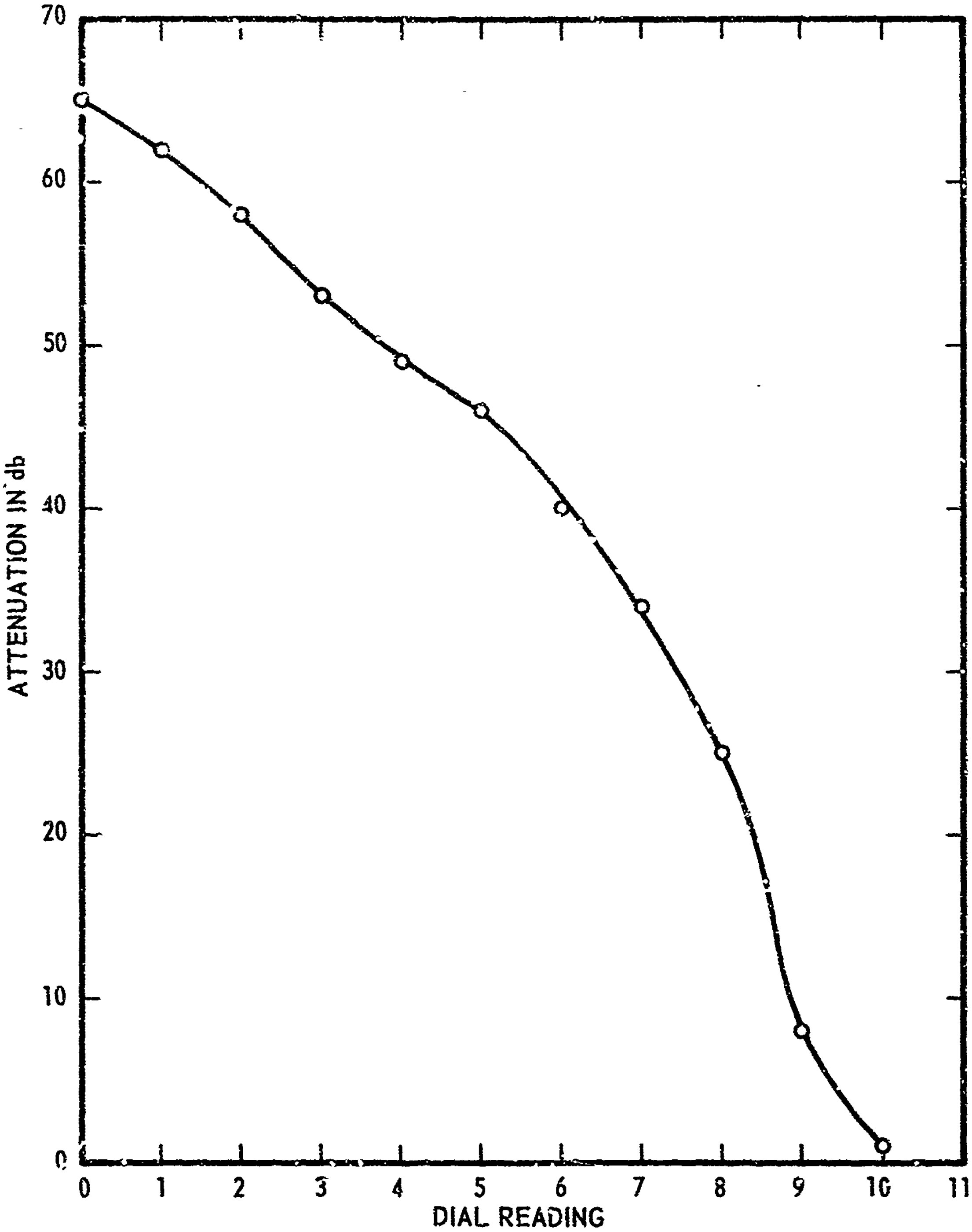


Figure 7. Charateristics of the Variable Attenuator.

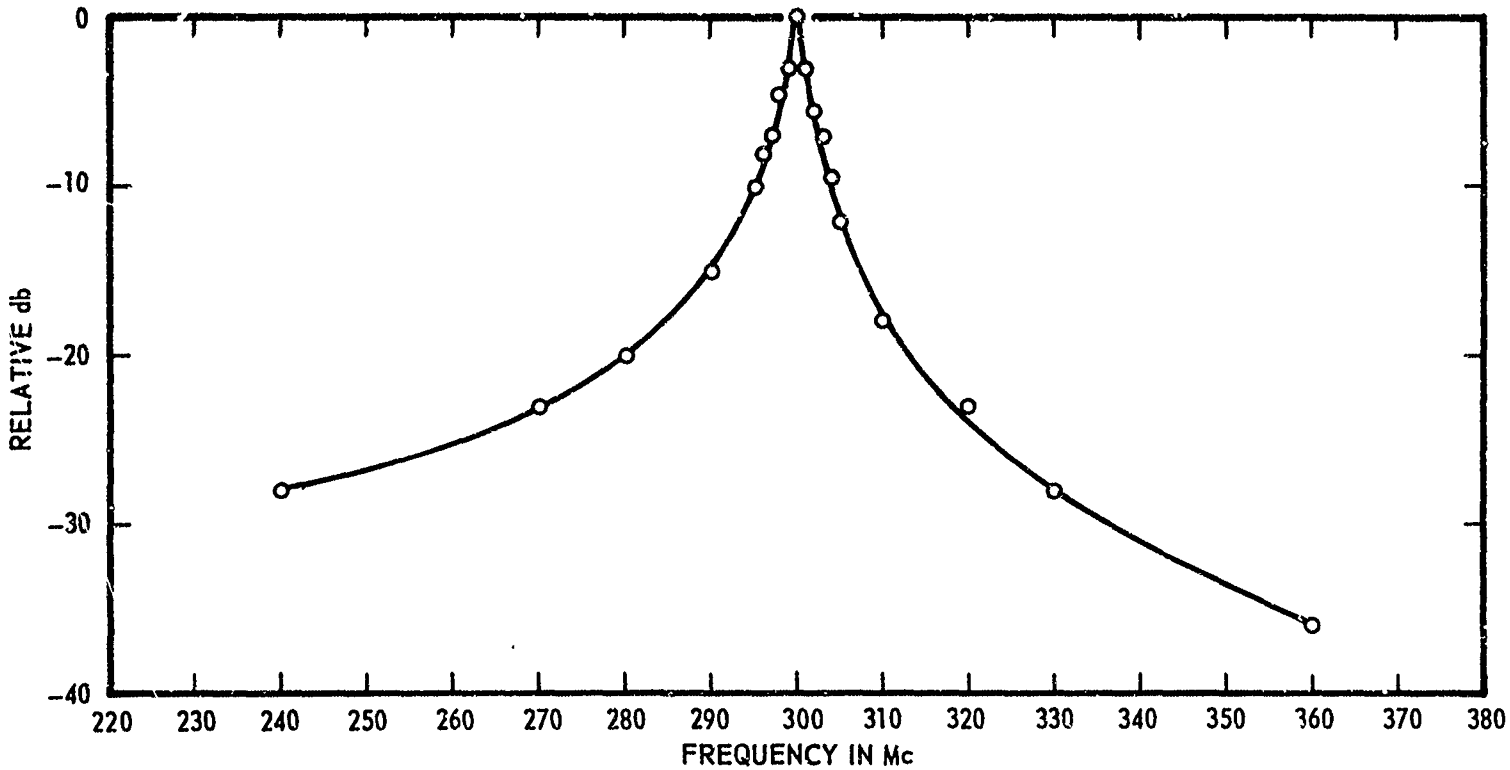


Figure 8. Preselector Selectivity Characteristic.

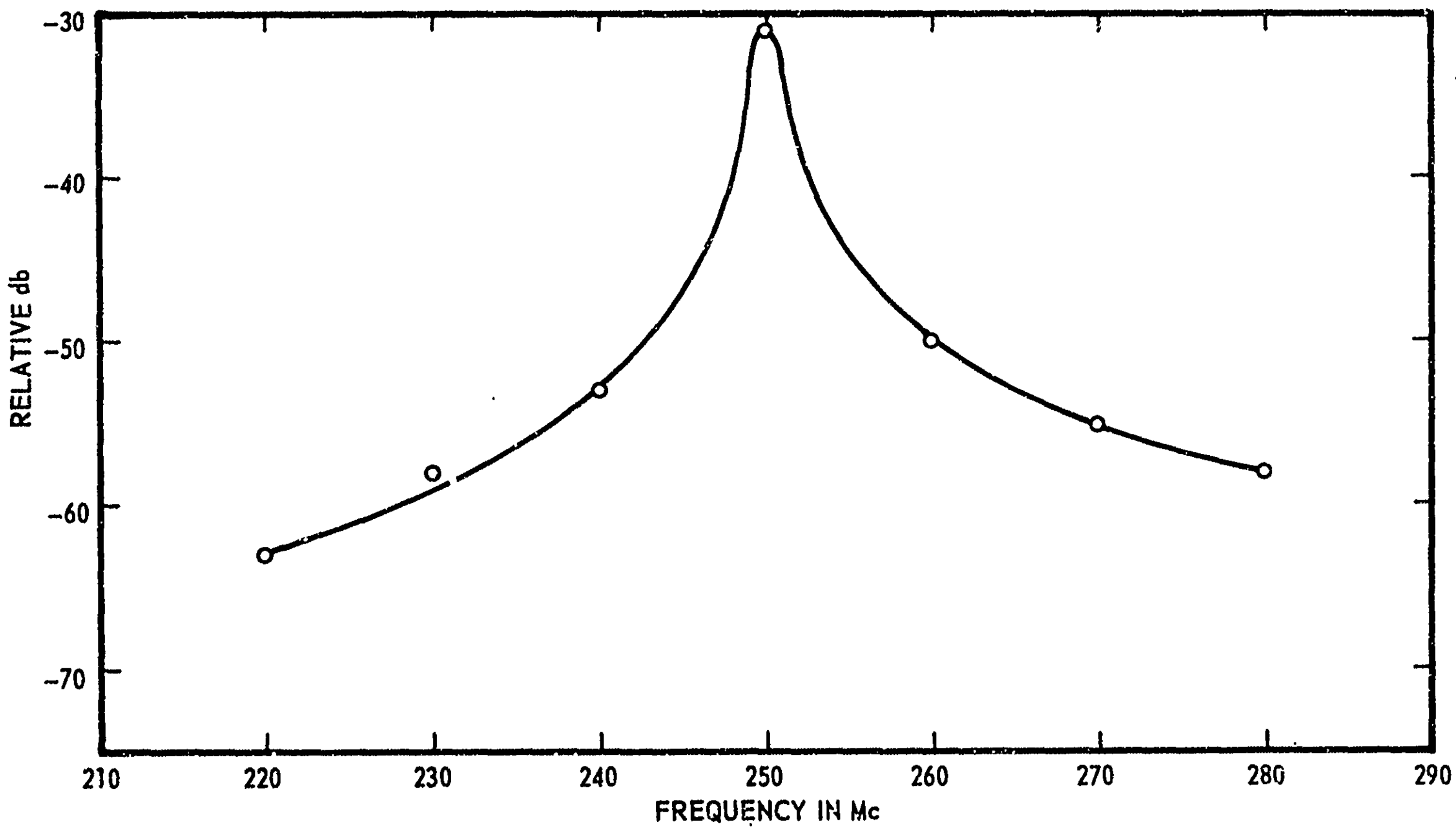


Figure 9. Preselector Isolation Characteristic.

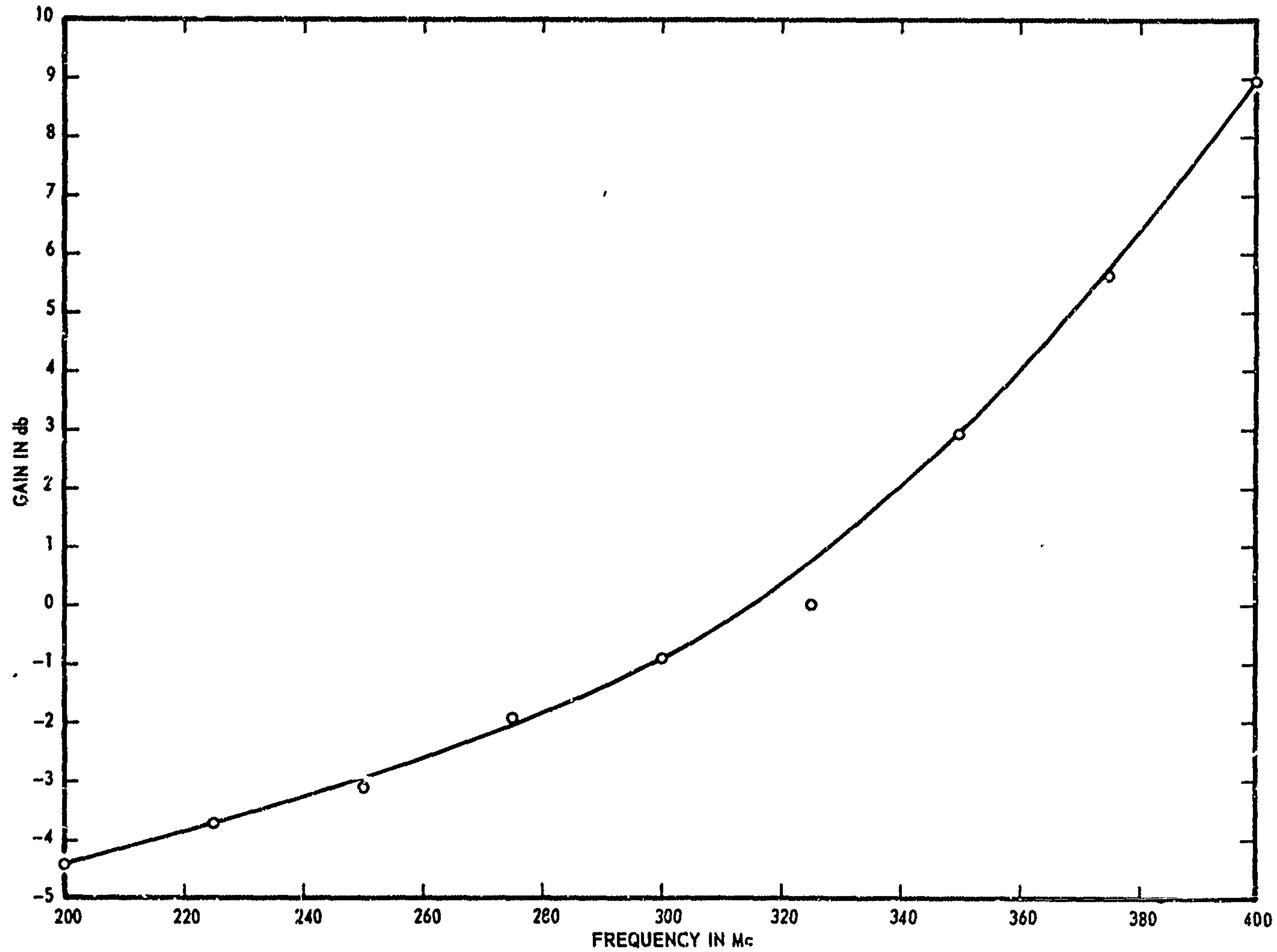


Figure 10. Preselector Gain Characteristic.

caused by the low value of the resonant impedance of the tuned circuit at the low frequency end of the tuning range. However, the main function of the preselector is to provide local oscillator isolation and image rejection rather than gain. A more elaborate tuned circuit, i.e., one with variable inductive and capacitive reactances, would have been necessary to provide gain across the entire band. Since the desired signal does not pass through the preselector, the loss of the preselector has no effect on the level of desired signal at the output of the filter.

2.2.7 Hybrid Network

Two hybrid circuits are used to split the local oscillator signal for the two mixers and to add the cancellation signal to the input signal appearing at the cancellation filter. Both of these hybrids are of the wide-band resistive type. Although the insertion loss of a resistive hybrid is rather high, it is a simple means of providing a wide-band hybrid with good isolation. Figure 15 includes a schematic of the hybrid circuit. The insertion loss of the hybrid is approximately 7 db, and the isolation between the output ports is greater than 30 db over the 200-400 Mc frequency range. A potentiometer is provided for balancing the hybrid to obtain maximum isolation. Note that the insertion loss of the adder (7 db) is a loss to the desired signal passing through the filter.

2.2.8 IF Amplifiers

Two similar 30 Mc IF amplifiers are used in the signal and cancellation channels of the filter. The signal channel amplifier has a gain of approximately 75 db and a passband characteristic as presented in the curve of Figure 11. For input levels below -65 dbm, the 3 db bandwidth is approximately 2 Mc. Figure 16 is a schematic of the IF amplifier. A simple diode mixer is included in each IF amplifier module to produce the interfering and cancellation IF signals.

In the cancellation channel, the output of the cancellation oscillator is attenuated by 46 db before being mixed with the local oscillator to obtain the translated 30 Mc cancellation signal. The 46 db attenuation isolates the cancellation oscillator from the local oscillator feedthrough. The IF amplifier increases the level of the translated cancellation signal back up to that necessary to drive the phase detector. The gain of the cancellation signal IF amplifier is approximately 60 db, and the 3 db bandwidth at power levels below -50 dbm is approximately 3 Mc. Figure 17 is a schematic of the amplifier and mixer combination used in the cancellation channel.

2.3 Equipment Construction

The cancellation filter was constructed in modular form to reduce cross coupling between the various components involved. The modules were constructed of tin plated steel which allowed connections to be soldered directly to the module walls.

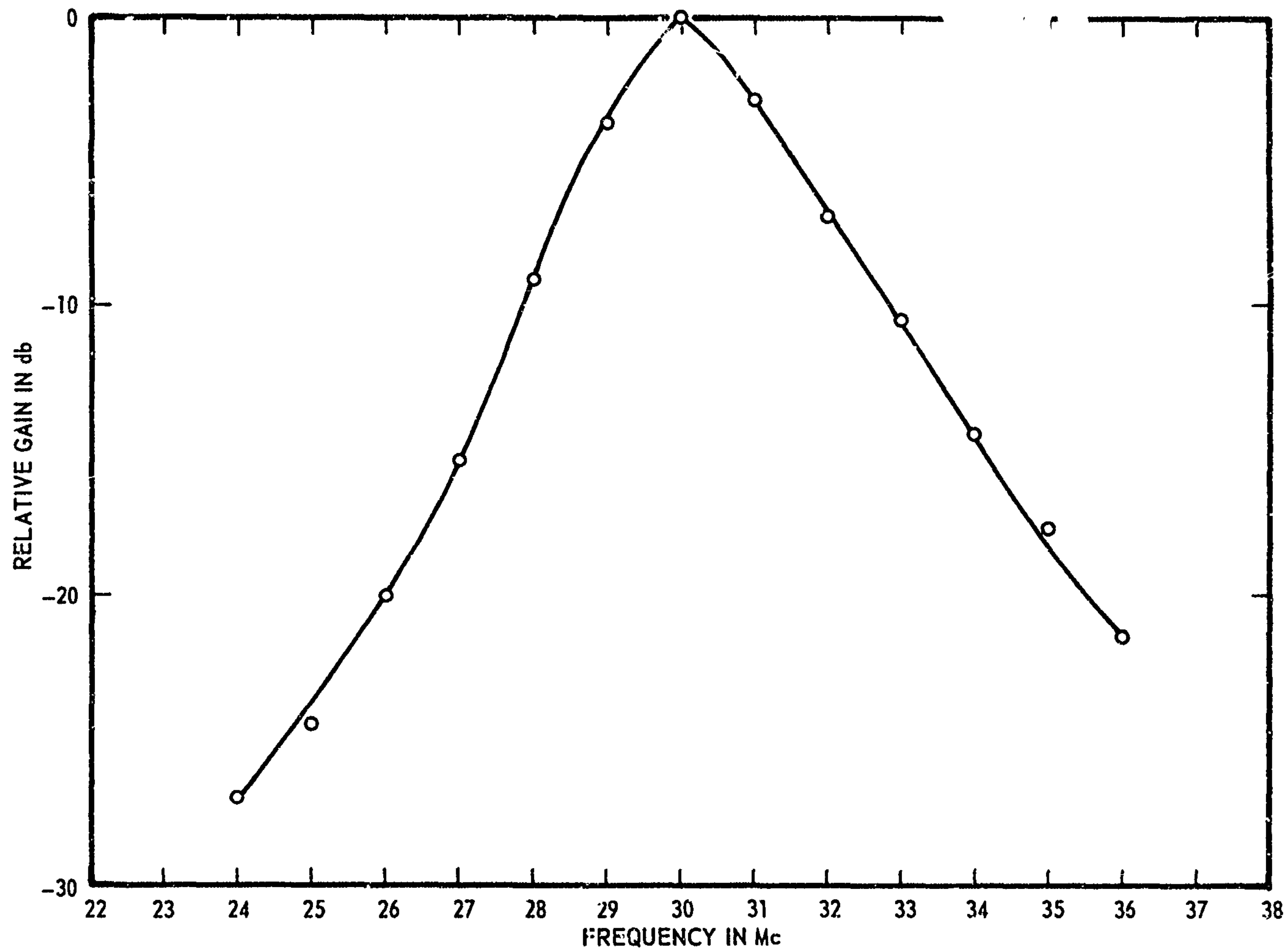


Figure 11. Signal Channel 30Mc IF Amplifier Selectivity.

The main chassis is made of alodined aluminum, and the modules are mechanically and electrically attached so as to establish a good ground system throughout the entire filter.

Figures 12 and 13 are photographs of the top and bottom of the filter model. The individual modules are labeled for identification purposes. Figure 14 is a photograph of the front panel.

The power supplies are located on the bottom side of the filter in two separate modules. The high voltage (75 volts) and filament voltage for the nuvistors are supplied by one module. The low voltage supplies (-6v, + 6v, -12v) for the transistors are supplied by the second module. Figure 18 is a schematic of the power supplies.

2.4 Operating Instructions

The cancellation filter model described in this report can be used in conjunction with any receiver operating in the frequency range 200-400 Mc. The interference power level must lie between -10 dbm and -70 dbm. The filter is designed to cancel CW interference which is sufficiently larger than the desired signal to desensitize the receiver. The following paragraphs give a detailed explanation of the operating procedure of the filter.

The antenna to be used with the receiver is connected to the input connector on the front panel of the cancellation filter. The output connector, also on the front panel, is connected to the antenna jack on the receiver.

The receiver can be used in the normal manner with the filter

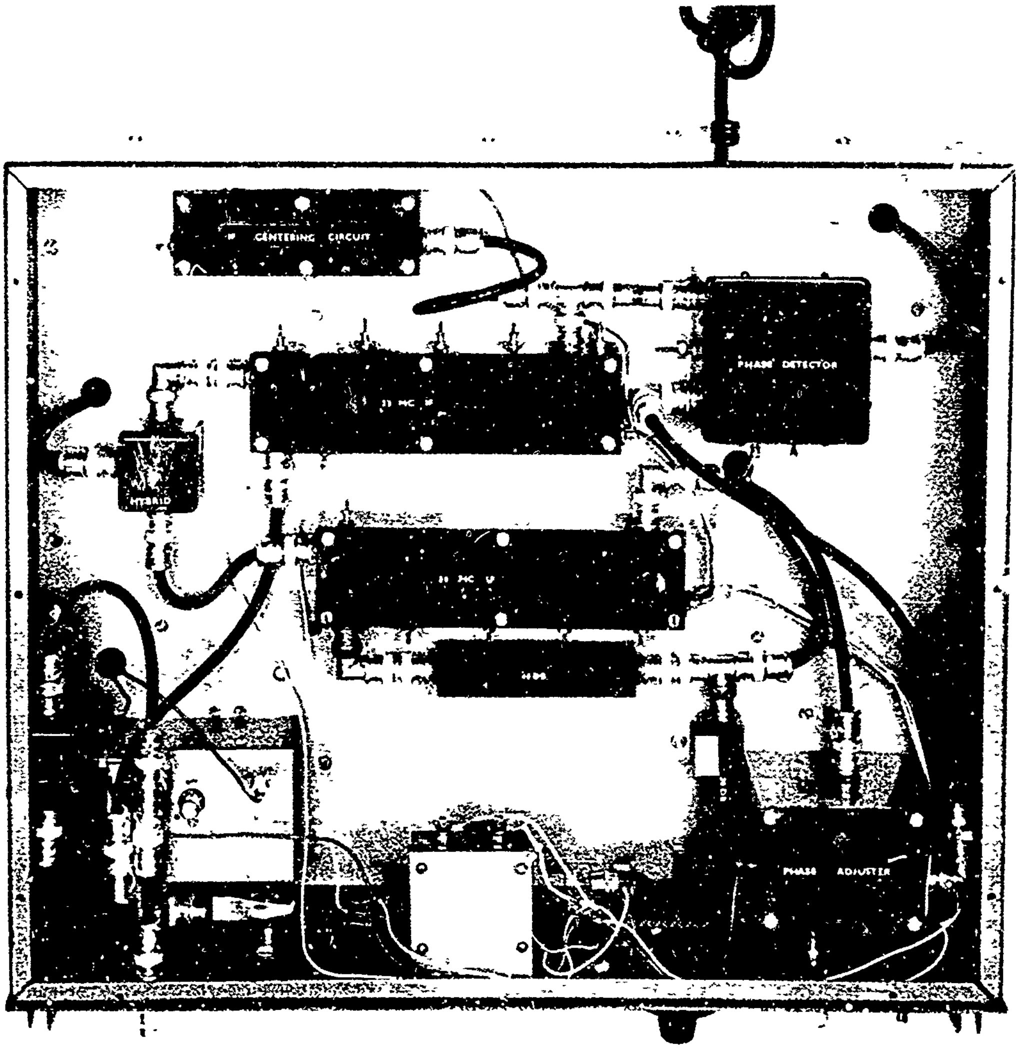


Figure 12. Top View of the Cancellation Filter.

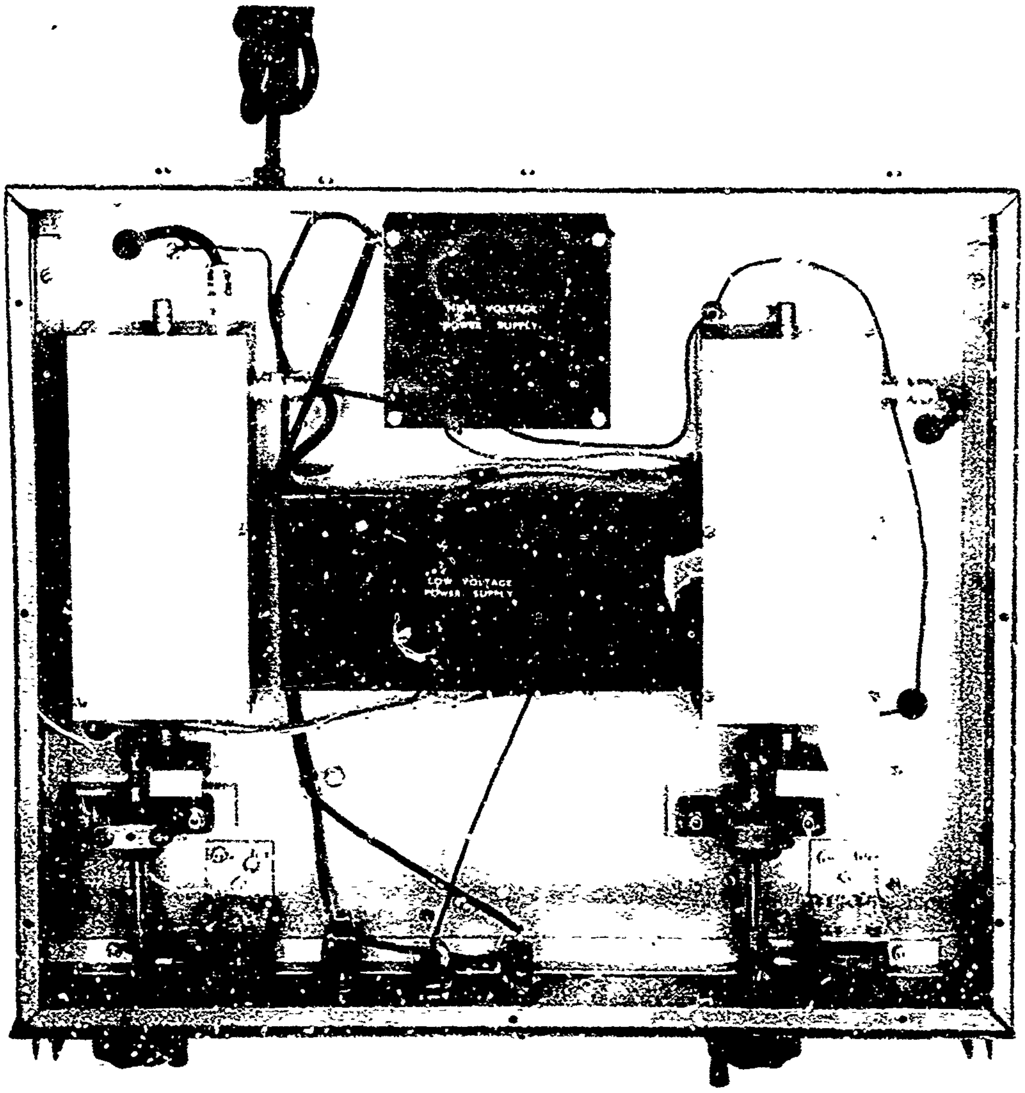


Figure 13. Bottom View of the Cancellation Filter.

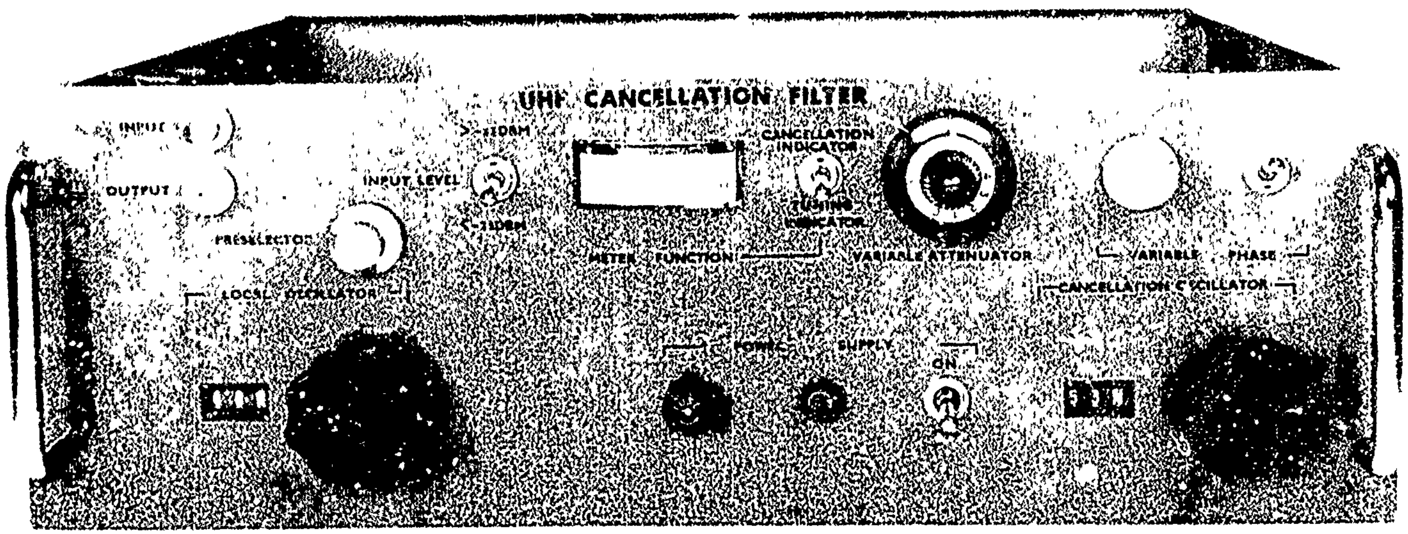


Figure 14. Front Panel of the Cancellation Filter.

connected in series with the antenna lead by switching the power of the filter off, or by placing the meter function switch on the front panel to the tuning indicator position. When the meter function switch is in this position, the cancellation oscillator B^+ is off and no signal is added to the signal from the antenna.

If an interference is present which desensitizes the receiver, the procedure for eliminating the interference is as follows:

(1) Set the variable attenuator control fully counter-clockwise.

(2) Set the meter function switch to the tuning indicator position.

(3) Adjust the local oscillator until the counter reads the number determined from the tuning curve located on the top of the filter for the tuned frequency of the receiver.

(4) Set the input level switch to the ≤ -35 dbm position.

(5) Tune the preselector to obtain a peak reading on the meter. If the peak reading is greater than half scale, set the input level switch to the ≥ -35 dbm position.

(6) Retune the local oscillator to obtain a peak reading on the meter. If the peak reading is greater than half scale, set the level switch to the ≥ -35 dbm position.

(7) Set the meter function switch to the cancellation indicator position.

(8) Tune the cancellation oscillator until the counter reads the number determined from the tuning curve for the tuned frequency of the receiver. Somewhere close to this counter reading a meter deflection will be obtained. The cancellation oscillator should be tuned until the meter "drops" into a null. This indicates that the cancellation oscillator is locked to the interference if the interference signal is sufficiently larger than the desired signal. This is generally the case when the interference desensitizes the receiver.

(9) Adjust the variable attenuator and the phase adjuster controls until the desired signal is heard from the audio output of the receiver. The phase shifter has two controls -- a potentiometer which provides approximately 359° of continuous phase variation and a switch which provides an additional 180° phase shift. The potentiometer control is usually sufficient to cancel the interference. However, occasionally it may be necessary to operate the phase reversal switch to obtain cancellation of the interference. The switch can be left in either position.

Step (9) may be difficult if the interference is much larger than the desired signal because the phase and amplitude adjustments are quite critical in this case. Usually the variable attenuator can be adjusted until the loudest hiss is heard from the receiver. The phase can then be varied until the desired signal can be heard. If no setting of the attenuator provides a maximum hiss, operate the phase switch providing a 180° phase adjustment and then readjust the continuous phase control while listening for the desired signal.

2.5 Performance Tests

The cancellation filter was tested on various simulated interference problems. Two signal generators were used to simulate a CW interference signal superimposed on a desired AM signal. The signal-interference combination was fed through the filter and into an Air Force R-278 B/GR receiver. Several signal and interference power levels were combined, and the cancellation filter successfully removed the interference. For interference-to-signal ratios greater than 50 db, the phase and amplitude adjustments become critical.

Interference can be eliminated reasonably well for interference-to-signal ratios lying between 10 db and 40 db.

When the interference is very close to the desired signal (within 10 kc), the desired signal is allowed to pass through the low-pass loop filter. The cancellation oscillator frequency is varied by the signal being superimposed on the error voltage from the phase detector. The result is an audible signal at the output of the receiver; therefore, for interference very close to signal, the filter performance is limited. The bandwidth of the low-pass filter determines how close to the desired signal the interference can lie for successful cancellation. If the bandwidth is too low, the cancellation oscillator will not remain locked to the interference due to the instability of the oscillator as well as the interference itself.

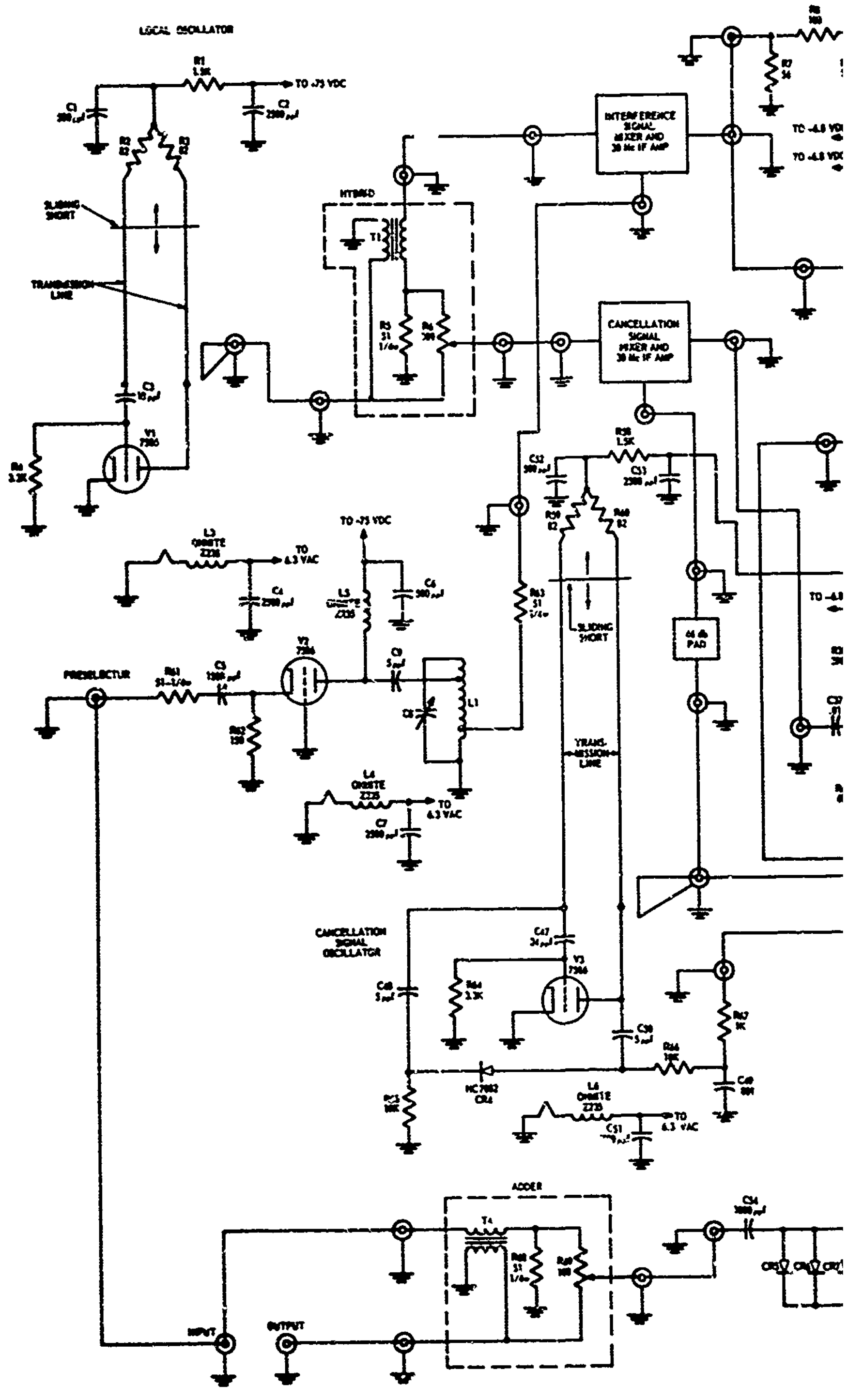
3. CONCLUSIONS AND RECOMMENDATIONS

The UHF active filter developed on this contract proved to be successful in eliminating CW interference when the interference-to-signal ratio is less than 40 db and if the interference lies more than an audio bandwidth away from the carrier of the desired signal. When the interference is within audio range of the desired signal carrier, the performance is limited because an annoying audible signal is heard from the receiver as the frequency of the cancellation oscillator is pulled by the desired signal.

The principle on which the filter design is based has been proven to be satisfactory by the model, i.e., other filters could be built employing this technique in other frequency ranges. Simply scaling the components used in the model down to lower frequencies would provide filters anywhere in the range from VHF to UHF.

It is recommended that an investigation be made of the possibility of cancelling an entire AM interference signal with an addition to the existing filter. If the undesired AM signal envelope were detected and fed into the current-controlled attenuator, the output cancellation signal would also be AM. Thus, by placing an amplifier between the envelope detector and the current-controlled attenuator, the percent modulation on the cancellation signal could be made the same as that of the undesired signal. Cancellation of an entire AM signal would then be possible.

Other additions to the filter which are recommended are automatic phase and amplitude controls of the cancellation signal. These two additions would make it unnecessary to adjust the phase and amplitude of the cancellation signal for small amplitude variations in the undesired signal.



LOCAL OSCILLATOR
TO -75 VDC
SLIDING SHORT
TRANSMISSION LINE
HYBRID
INTERFERENCE SIGNAL MIXER AND 30 Mc IF AMP
CANCELLATION SIGNAL MIXER AND 30 Mc IF AMP
PRESELECTOR
TO 6.3 VAC
CANCELLATION SIGNAL OSCILLATOR
ADDER
INPUT
OUTPUT

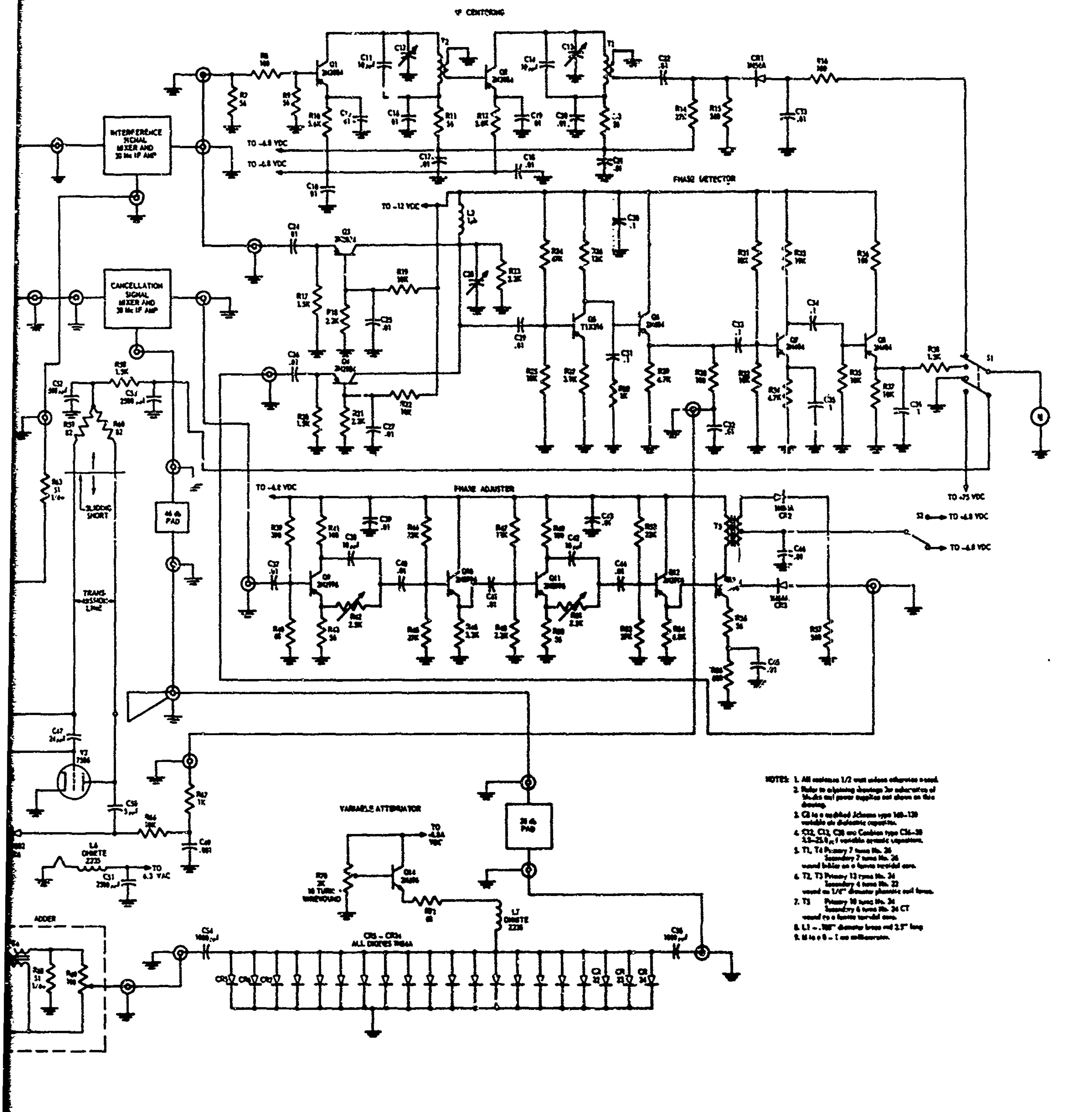
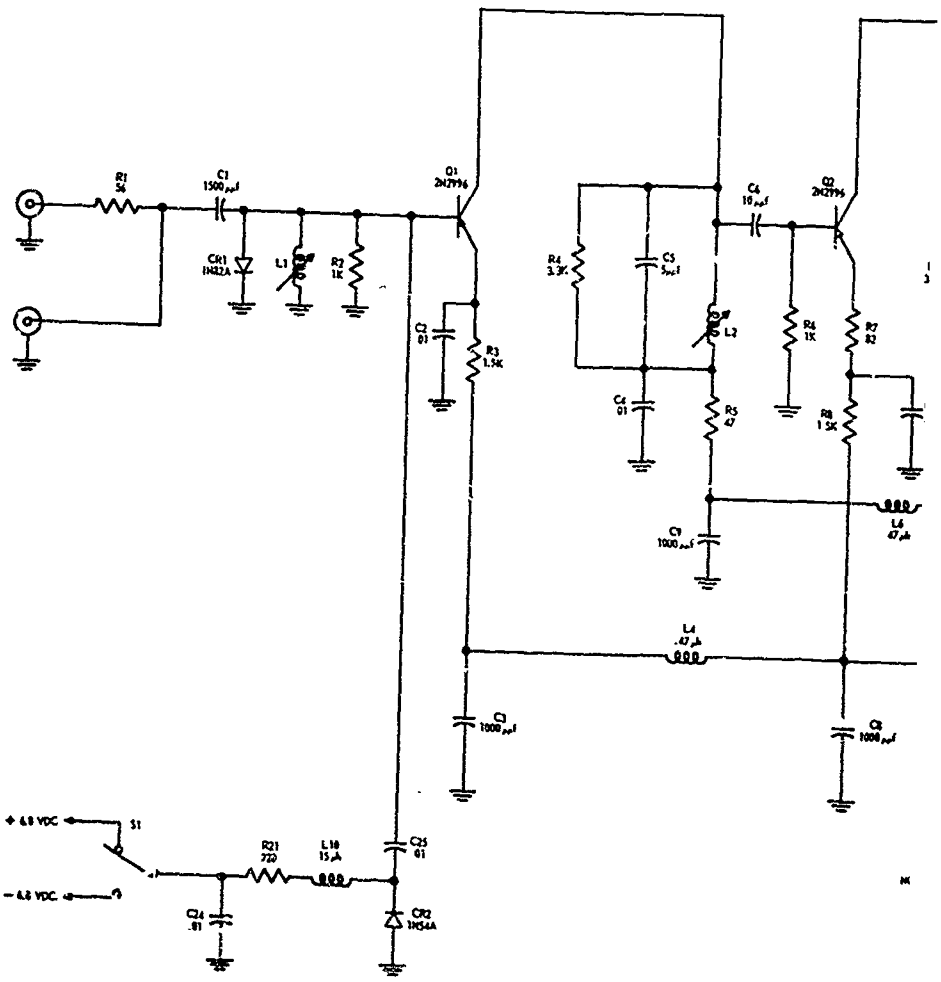


Figure 15. UHF Cancellation Filter Schematic Diagram



R1
56
C1
1500 µµf
CR1
1N82A
L1
R2
1K
Q1
2N2996
C2
.01
R3
1.5K
R4
3.3K
C5
5µµf
C6
10 µµf
Q2
2N2996
L2
R6
1K
R7
82
C4
.01
R5
47
R8
1.5K
C9
1000 µµf
L6
47 µh
L4
.47 µh
C3
1000 µµf
C8
1000 µµf
+ 6.8 VDC
S1
– 6.8 VDC
R21
220
L10
15 µh
C25
.01
C24
.01
CR2
1N54A

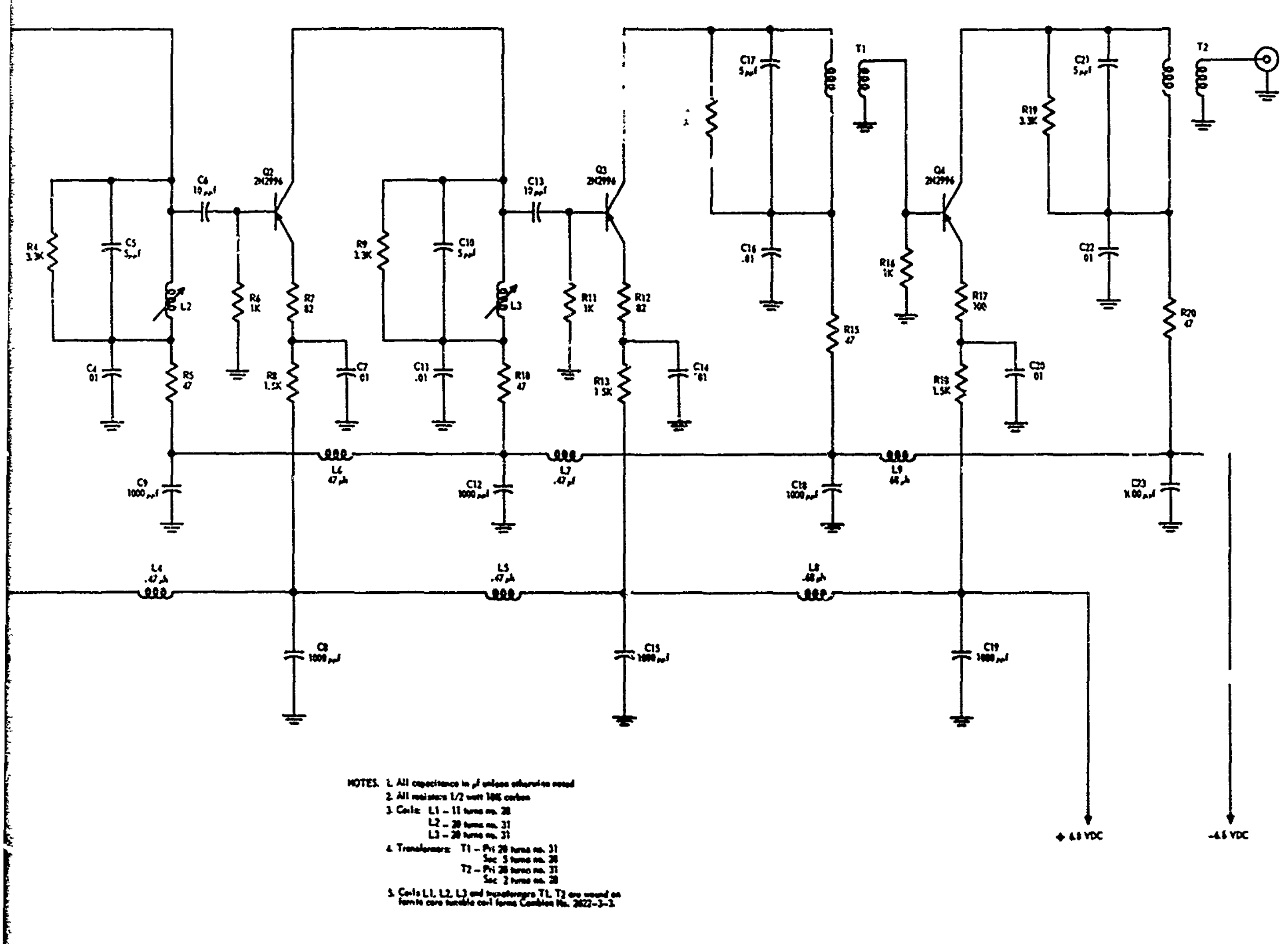


Figure 16. Signal Channel 30 Mc IF
Amplifier Schematic Diagram

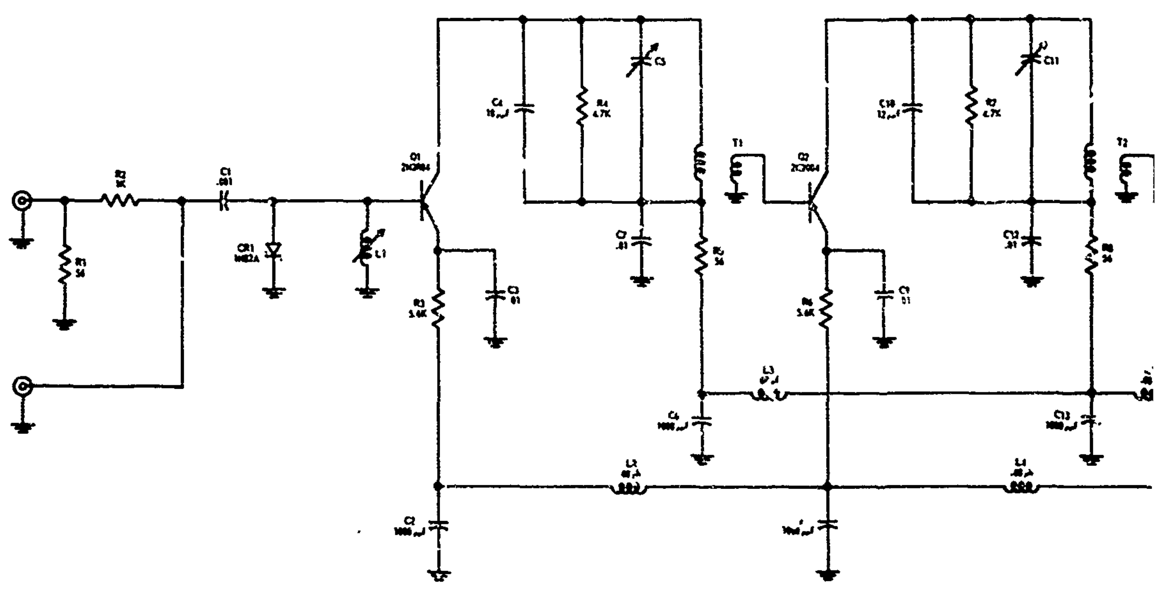


Figure 17. C
A

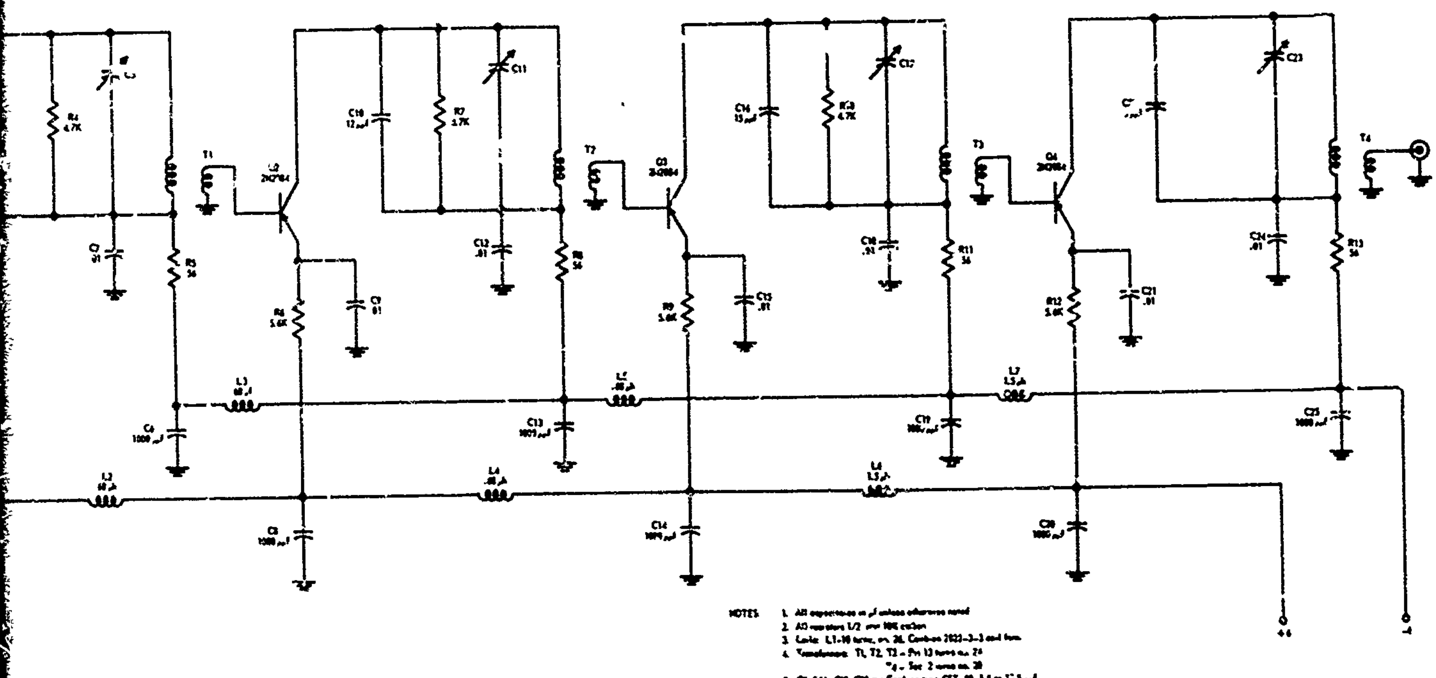
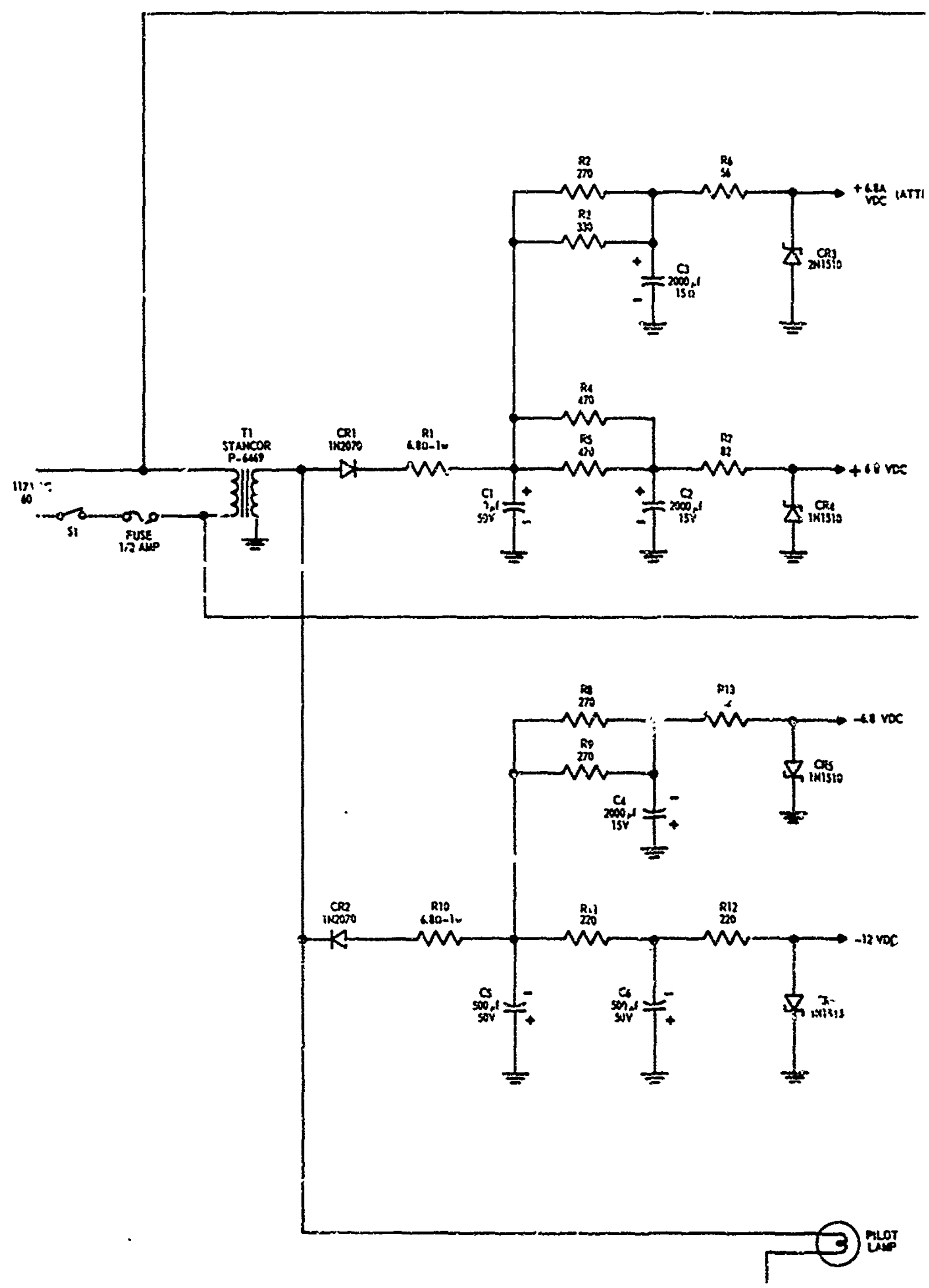


Figure 17. Cancellation Channel 30 Mc IF Amplifier Schematic Diagram

2

LOW VOLTAGE POWER SUPPLY



Figure

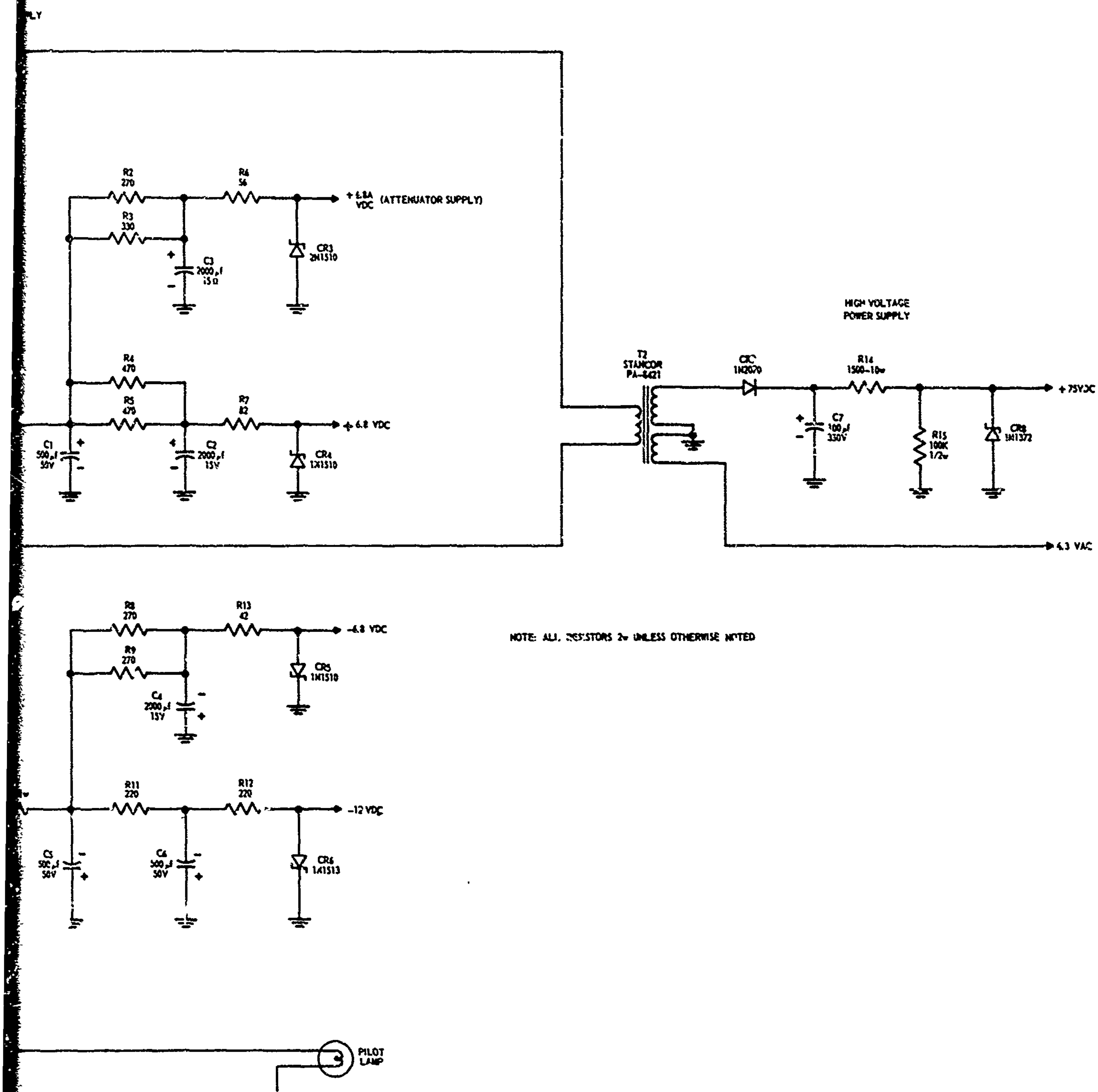


Figure 18. Power Supply Schematic Diagram

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13. ABSTRACT

This report describes a UHF cancellation filter for use over the frequency range 200-400 Mc. The filter can reject CW interference by phase locking an oscillator to the interfering signal and adding the phase-locked signal in such a manner as to produce cancellation of the interference. A superheterodyne system is employed so that interfering signals as low as -80 dbm may be cancelled throughout the 200-400 Mc frequency range. By careful adjustment of the phase and amplitude of the cancellation signal, the interfering signal can be reduced as much as 60 db.

The cancellation filter is designed for use in a 50 Ω system and is inserted between the antenna and receiver. When the cancellation filter is inoperative, the receiving system may be used in a normal manner with the filter remaining in the receiving system.

50 ohms

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14 KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Active Cancellation Filter						
Reject CW Interference						
Phase Locking Techniques						

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