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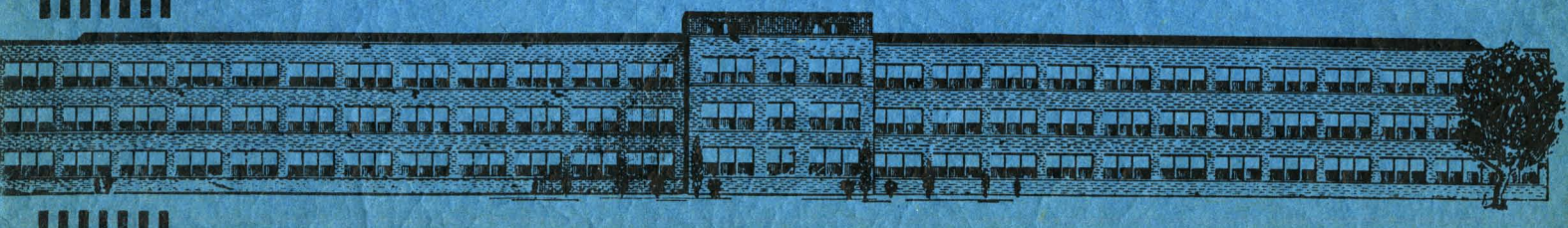
AN EXPERIMENTAL UHF TELEVISION TUNER

RADIO CORPORATION OF AMERICA
RCA LABORATORIES DIVISION



RADIO CORPORATION OF AMERICA
RCA LABORATORIES DIVISION
PRINCETON, N. J.

E W ENGSTROM
VICE PRESIDENT IN CHARGE OF
RESEARCH

December 12, 1949.

Mr. T J Slowie, Secretary
Federal Communications Commission
Washington 25, D C.

Re Docket Nos. 8736, 8975
9175 and 8976
Part II

Dear Sir

Because of the necessity of giving all of our attention to the tests of November 21 and 22, there has been a break in the schedule of issuing technical information related to color television. However, we now resume this program and file herewith 100 copies of the fourth bulletin * entitled, "An Experimental UHF Television Tuner." This information is of interest to the radio industry because of our Bridgeport, Connecticut, UHF television transmissions scheduled to begin shortly after the first of the year and because of the relationship of UHF tuners to the current hearing Copies of this bulletin will be mailed to the list of persons and organizations attached to Mr Robert Zeller's letter of October 26.

At an early date another bulletin will be issued covering the direct-view color receiver of the type used during the tests of November 21 and 22.

Very truly yours,

E. W. Engstrom

E W Engstrom

*Bulletins previously filed and distributed

"A 15 by 20-Inch Projection Receiver for the RCA Color Television System" (letter dated October 20, 1949)

"Synchronization for Color Dot Interlace in the RCA Color Television System" (letter dated October 31, 1949)

"A Two-Color Direct-View Receiver for the RCA Color Television System" (letter dated November 9, 1949)

An Experimental UHF Television Tuner

Radio Corporation of America

December 1949

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An Experimental UHF Television Tuner

Introduction

This bulletin describes a u-h-f television tuner developed to aid in the field tests of an NBC experimental television transmitter scheduled to commence operation in Bridgeport, Conn early in 1950

Since the Bridgeport transmitter will operate in the lower frequency region 529-535 Mc of the u-h-f band it has been possible to attain satisfactory performance using conventional tubes in this particular tuner which covers the range from 500 to 700 Mc A tuner which is to perform satisfactorily in the frequency region above 700 Mc would probably require a different tube complement, and perhaps other design changes For this reason, the tuner described in this bulletin is not intended to represent a finished commercial design, but rather is an experimental model to be used on a limited basis to acquire further technical information pertinent to u-h-f television transmission and reception

The amplified output signal of the tuner is fed to the i-f amplifier of any conventional television receiver Both the tuner and its power supply may be mounted directly on the television receiver chassis or operated as a separate unit

General Considerations

As shown in the block diagram of Fig 1, the tuner consists of an input high-pass filter cutting off at 500 Mc an r-f amplifier, first mixer-oscillator, 132-138-Mc first i-f amplifier, and second fixed-tuned mixer-oscillator, the output of which is at 21-27 Mc and low impedance The u-h-f amplifier and oscillator tuning elements are designed to cover the signal range of 500 to 700 Mc

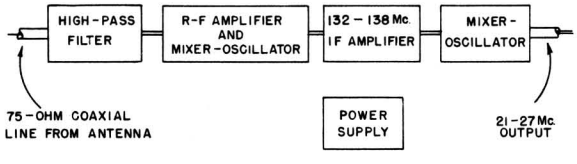


Fig. 1 - Block diagram of u-h-f tuner and power supply

The first i f has been chosen high enough to provide satisfactory image rejection with two u-h-f tuned circuits, but low enough so that reasonable i-f gain and noise factor can be realized with conventional amplifier tubes

Description of Circuit

A circuit diagram of the tuner and its power supply is shown in Fig 2 The high-pass input filter reduces spurious responses most of which are at frequencies below 500 Mc since in a double-superheterodyne receiver the first local oscillator is below the signal frequency This filter, shown schematically in Fig 2 is a "printed" circuit, as shown in Figs 3 and 4 The "printing" is accomplished by photoengraving a 1 5-mil copper sheet bonded to a paper-base bakelite sheet The filter and r-f amplifier are designed to operate with coaxial 75-ohm antenna transmission line

A 6J4 triode is used as a grounded-grid amplifier, and a single 6J6 tube is used for

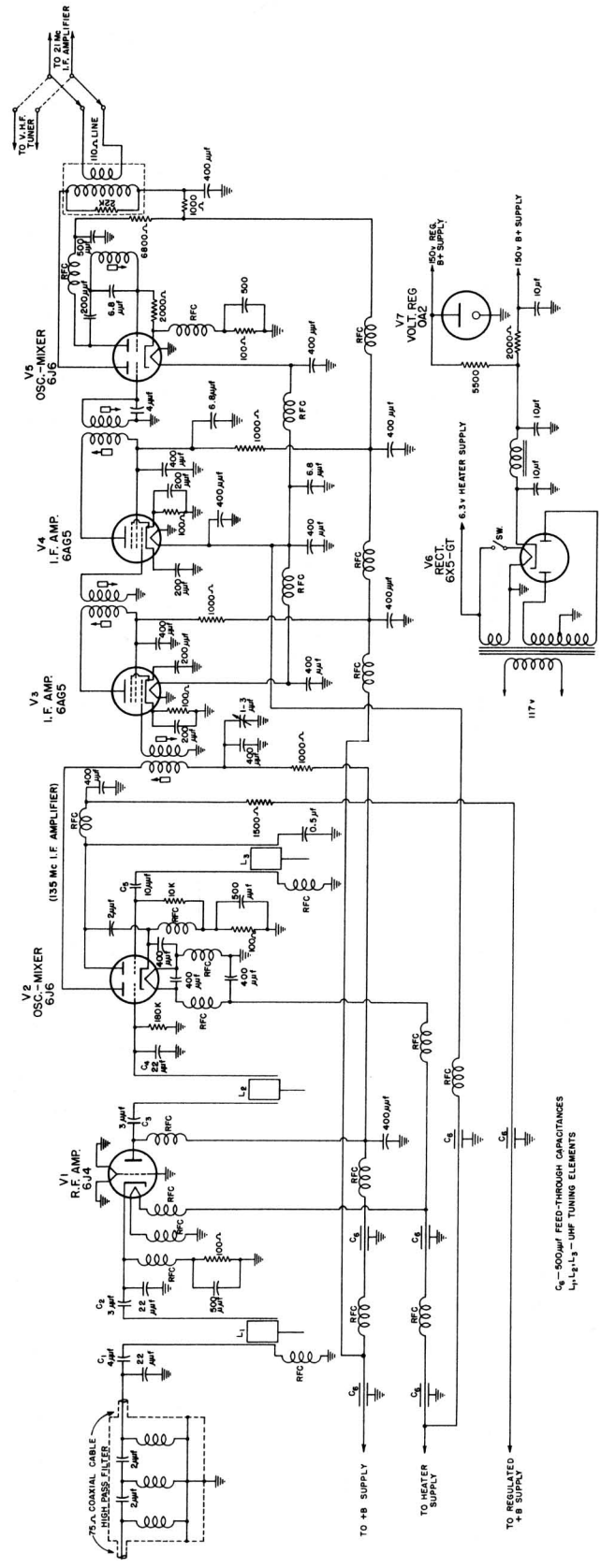
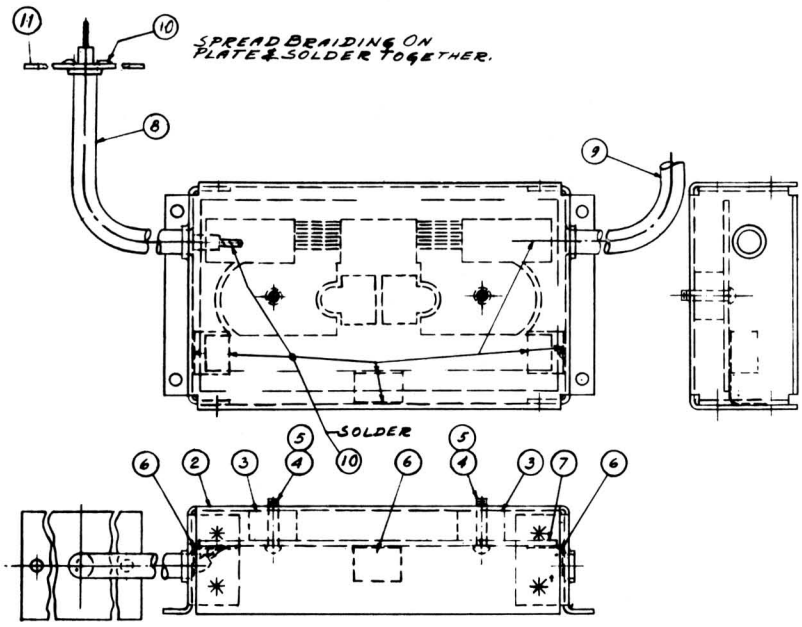
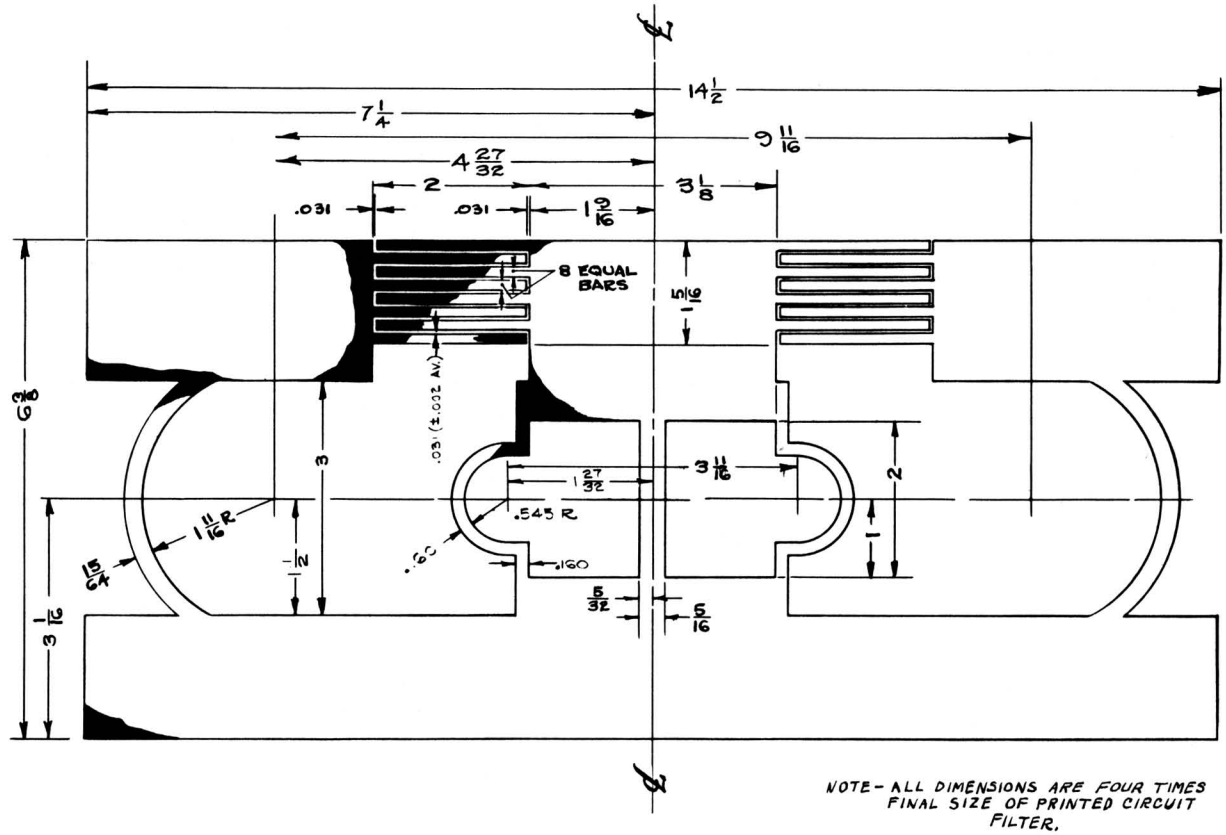


Fig 2 - Circuit diagram of u-h-f tuner and power supply



LIST OF PARTS		
QTY.	ITEM	DESCRIPTION
X	1	ASSEMBLY
1	2	SHIELD
2	3	SPACER
2	4	SCREW-FILLHD.-#4-40 x 1/2 LG.
2	5	LOCK WASHER
3	6	STRAPS
1	7	HIGH-PASS FILTER
1	8	CABLE
1	9	CABLE
SUF	10	SOLDER
1	11	PLATE

(a) Assembly



NOTE - ALL DIMENSIONS ARE FOUR TIMES FINAL SIZE OF PRINTED CIRCUIT FILTER.

(b) Layout

Fig 3 - High-pass filter

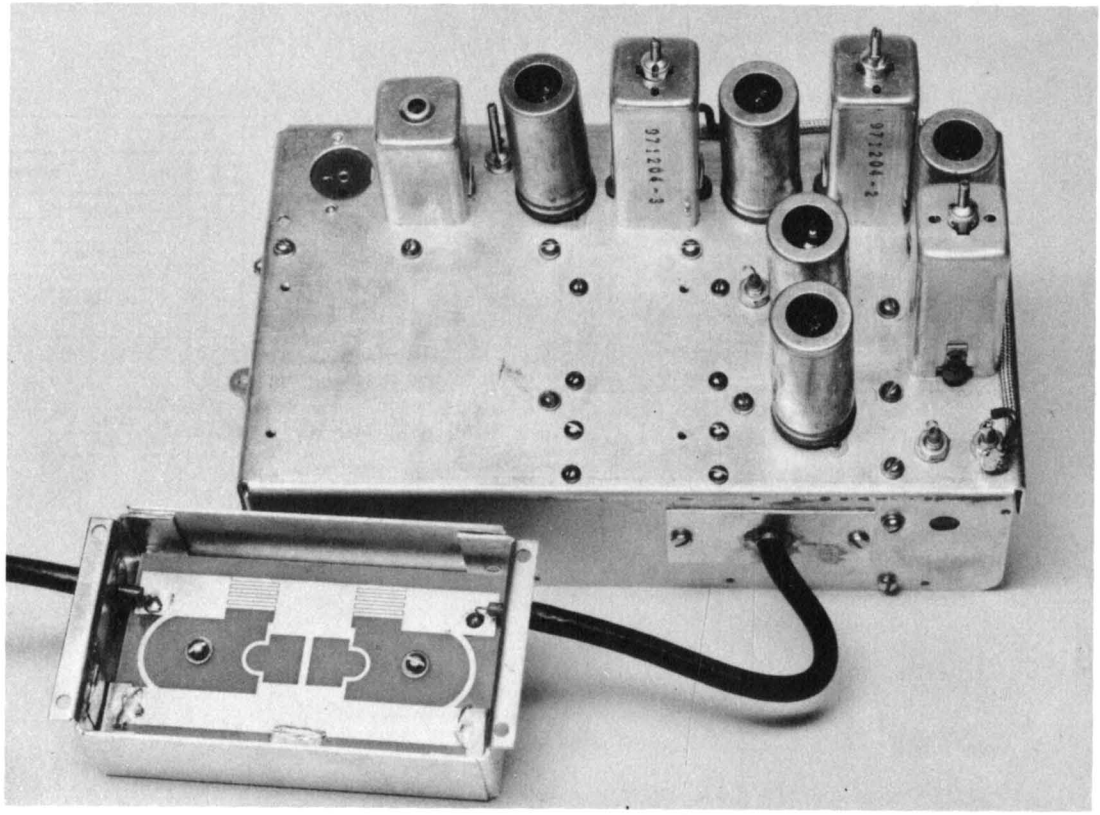


Fig. 4 - Photograph of tuner showing high-pass f lter.

the first oscillator-mixer, with cathode inject on of the oscillator vo tage

The 132-138-Mc first i-f amplifier consists of two stages of 6AG5 tubes with three double-tuned circuits. Two stages are necessary to isolate the f rst and second osci lators suffic ently. Automatic gain control is not ap plied to th s ampl fier because of the marked effect of varying tube transconductance on the band shape.

Another 6J6 tube is used as the second osci lator-mixer to heterodyne the 132-138-Mc signal to 21-27 Mc. The output from the tuner can be link-coupled to the f rst picture i-f ampl fier of a standard televis on rece ver through a low-impedance line. 110-ohm shielded twin line is used in the tuner described here. If the tuner s to be used with a receiver wh ch has an .f. of other than 21-27 Mc, it is only necessary to retune the fixed oscillator to the appropriate frequency and redesign the output i-f transformer. Sw tchiny between the u-h-f tuner and the conventional v-h-f tuner (which is normal y an integra part of the te evision rece ver) is made in the ow-impedance link c rcu t. In some television receivers it may be necessary to modify either this sw tching arrangement, or the 21-27-Mc i-f amp ifier, since the link may a ter the band-pass characteristics of the amp ifier.

U-H-F Tuning Elements

The tuning elements used in the r-f and osci lator circuits are shown in Fig 5 These e ements consist of strips of copper foil mounted on natura paper-base bakelite tub ng with ow-loss cement Tapered copper foil s used to obtain a desirab e tun ng curve and proper tracking of the r-f and oscil ator circu ts. The osc lator element consists of a bifilar w nding term nating in a split capac tor section. Al three elements are tuned by means of copper or brass cores, as shown in Fig. 6, inside the bakelite tubing. A 500 to 700-Mc tuning range is covered with a core movement of approximate y 1-3/8 nches.

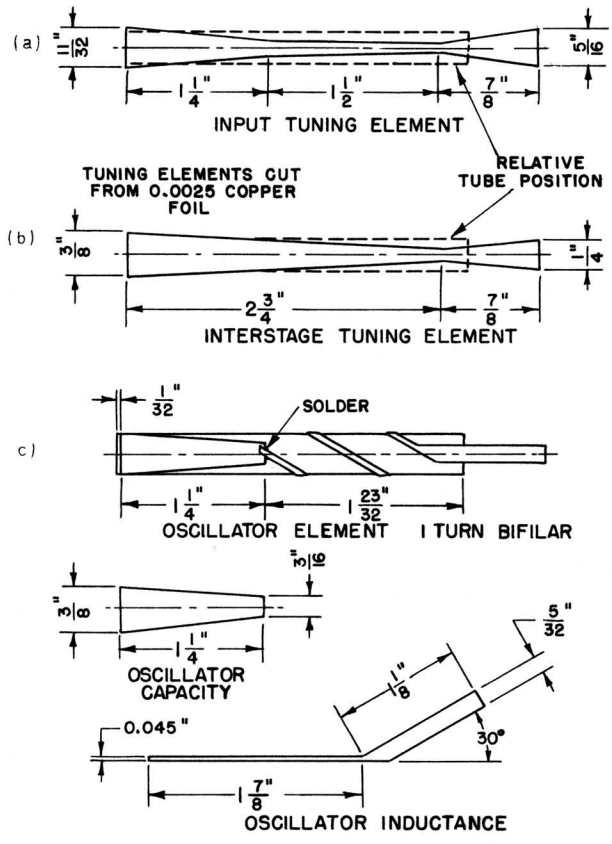


Fig. 5 - UHF tuning elements.

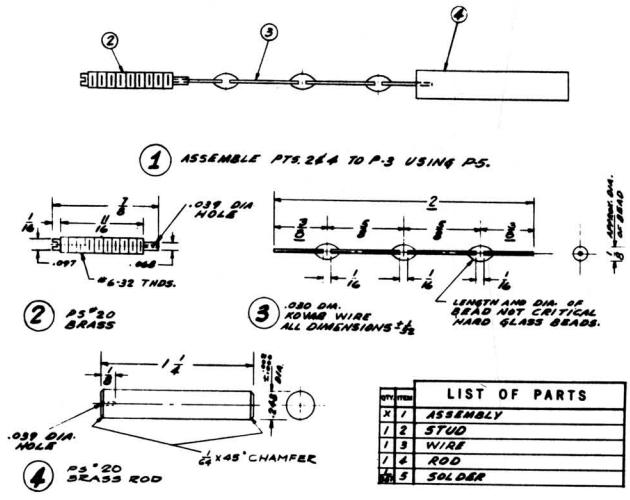


Fig. 6 - UHF tuning cores.

Fig 7 shows a bottom view of the tuner with the r-f and osc llator tuning elements in place. The 75-ohm coaxial cable from the high-pass filter can be seen to come in to the tuned circuit in the cathode of the grounded-grid stage. The tuning element between the plate of the grounded-grid amplifier and the m xer grid s shown in the center next to the oscillator tuning element. The 132-138-Mc i-f amplifier is placed near the edge of the chassis with the second mixer oscillator The output from the link transformer can be seen in the upper right hand corner.

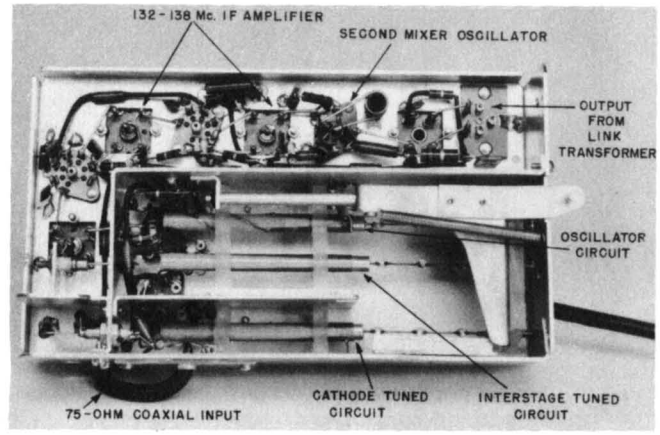


Fig. 7 - Bottom view of tuner chassis.

Input High-Pass Filter

The insertion loss of the high-pass f lter is shown n Fig. 8. In the transmission range, the insertion loss s about 2 db.

Performance

Noise Factor

No se factor measurements were made by the signal generator method. The noise factor is 14 db at 500 Mc, and 15 db at 600 and 700 Mc

Gain

The gain of the tuner open-circuit antenna to gr d of first 21-27-Mc amplifier tube) is 49 db at 500 Mc, 48 db at 600 Mc, and 47 db at 700 Mc.

Image Rejection and Spurious Responses

All of the image responses are more than 66 db down and the -f response is more than 80 db down from the main responses when the high-pass f lter is used in the input circuit.

n order to attain this degree of freedom from spurious responses, t is necessary to

decouple the fixed oscillator from the u-h-f circuit In addition to the mechanical shielding attained by careful placement of components, it is necessary thoroughly to decouple the plus B and heater supply leads

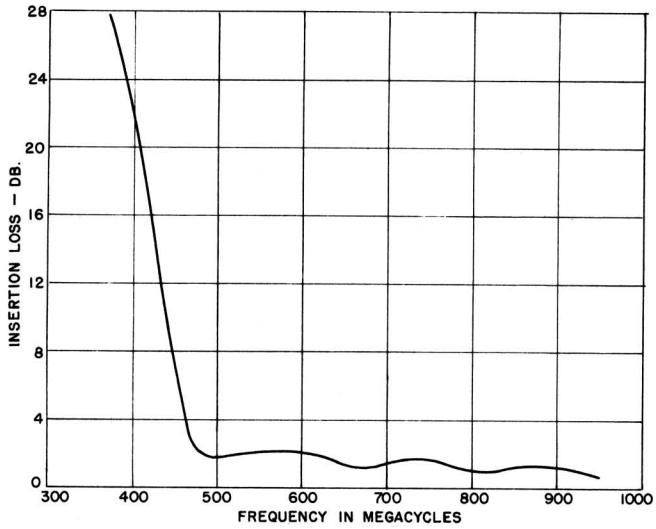


Fig. 8 - Insertion loss of high-pass filter

There is a spurious response caused by the fourth harmonic of the fixed oscillator 158 Mc feeding back to the input circuit at 632 Mc The 6 8-μμf condenser in the plus B supply line and the 1 to 3-μμf trimmer in the low side of the primary winding of the first 132-138-Mc transformer are used to suppress this 632-Mc harmonic The amount of this harmonic signal getting back to the tuner input depends on the position of the antenna input coaxial cable and the leads from the power supply This response can be further reduced with a 632-Mc trap circuit magnetically coupled to the fixed oscillator

Oscillator Stability

The u-h-f tuner operates with the filaments on at all times Regulation of the plate voltage for the u-h-f oscillator is necessary to prevent frequency change due to variations in supply voltage The oscillator drift at 500 Mc with preheated filaments is 150 kc measured 1/2 minute from the time B plus is turned on All of the drift occurs in less than 2-1/2 minutes the oscillator stabilizing after that time At 600 and 700 Mc the drift characteristics are very similar to those at 500 Mc

Tuning Characteristic and Tracking

The tuning curve for the tuner is shown in Fig 9 The tuning elements for the r-f and oscillator circuits track within 1/16 inch of core movement this tracking error, which corresponds to 7 to 10 Mc in frequency does not appreciably degrade the sensitivity The tuning curve consists very nearly of two linear sections from 500 to 600 Mc and 600 to 700 Mc

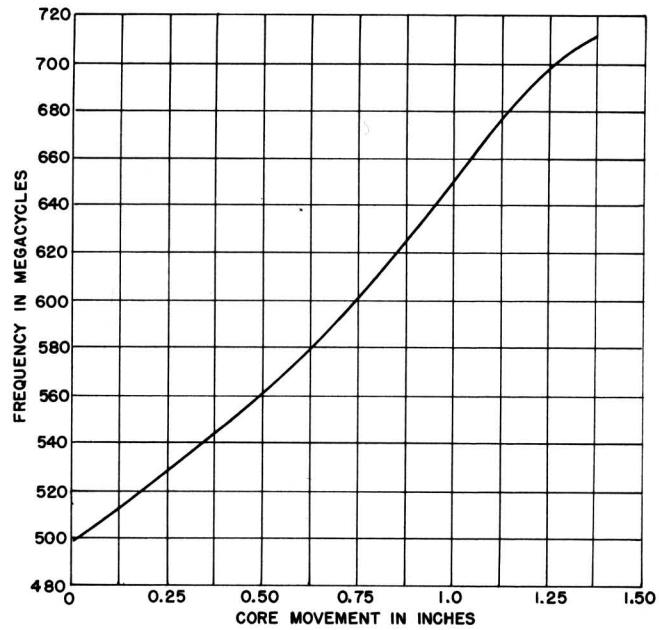


Fig 9 - Tuning curve for u-h-f tuner

Tracking is accomplished first by adjusting the lead length of the u-h-f oscillator capacitance C_5 Fig 2 with the oscillator core in its low-frequency position so that the frequency is about 365 Mc Concurrently, the u-h-f tuned circuits are tuned to 498 Mc with their cores in the low-frequency position by ad ustment of the lead lengths of capacitances C_1 to C_4 in Fig 2 If necessary the tracking is further improved over the band by adjustment of the relative positions of the cores

Construction Details

The tuner chassis does not include its power supply which is on a separate small chassis One method of mounting the tuner and its power supply is shown in Fig 10, where the tuner is mounted directly above the regular v-h-f tuner and the power supply is mounted in

front of the horizontal deflection-high voltage compartment. Fig. 11 shows the u-h-f tuning dial and directly be ow it the uhf-vhf switch. Obviously, for each different type of television rece ver with which the tuner s used, the mount ng problem will be different. It is even poss ble to use the tuner (and power supply) n a separate housing, perhaps with the uhf-vhf switch on the receiver.

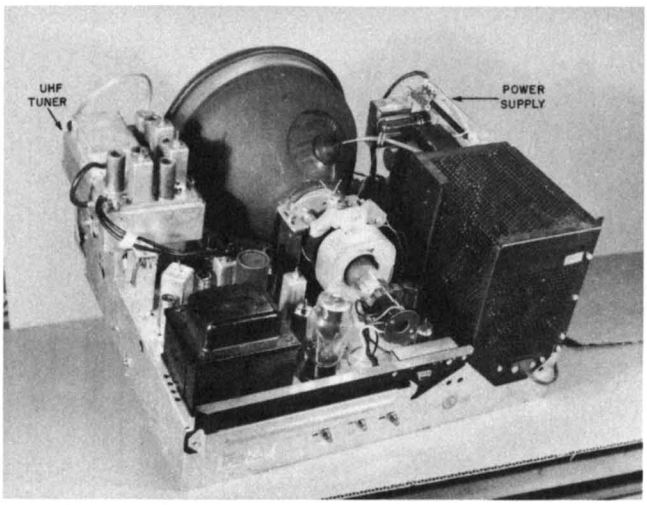


Fig. 10 - UHF tuner and power supply mounted on tele vision receiver chassis.

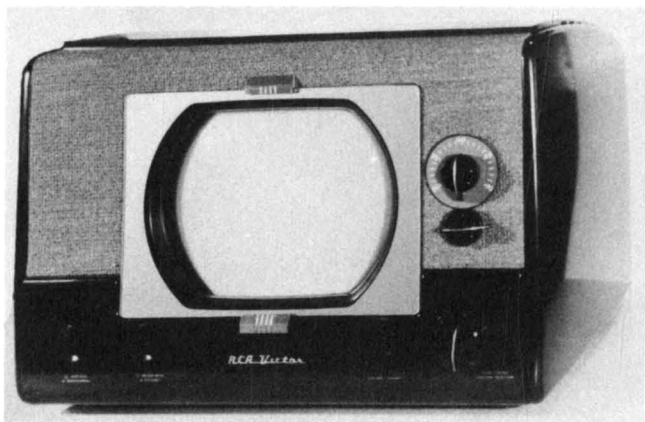


Fig. 11 - Front view of te ev sion receiver showing u-h-f dial and sw tch

Figs. 12 and 13 show sufficient electr cal details of the i-f transformers so that they may be duplicated with a minimum of engineering time.

If photoengraving and etching equipment is unavailable, the input high-pass filter can be made of umped constants The coils then consist of 1-1/2 turns of No. 16 w re, 1/4-inch inside diameter, and the condensers of 1/2 to 3-μμf tr mmers. Adjustment of the condensers is done empirically for best band-pass characteristics. Of course, the nput filter may be om tted entirely if desired, but with a degradation of the spurious-response rejection ratios.

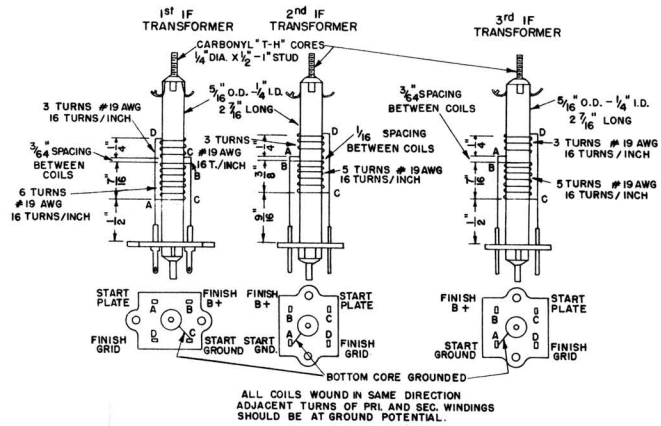


Fig. 12 - 132-138 Mc i-f transformer deta ls.

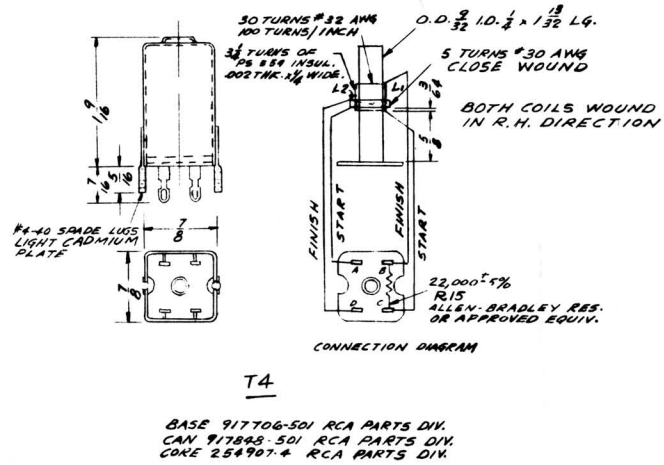


Fig. 13 - 21-Mc i-f ink transformer details.

As shown in Fig 6, the u-h-f tun ng cores are mounted on kovar wire which is broken in several places with glass bead supports. The use of kovar wire m nimizes oscillator drift due to thermal expansion. It s necessary to break the wire into small segments to decouple the cores from the surrounding metal and avoid spur ous "suck-outs".