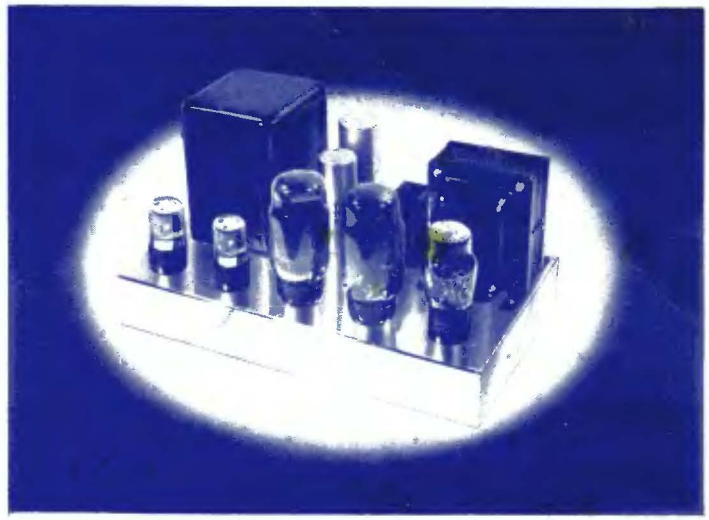
INSTALLATION and SERVICE INSTRUCTIONS

THE craftsmen 500

ULTRA FIDELITY AUDIO AMPLIFIER



ELECTRICAL SPECIFICATIONS

POWER OUTPUT: 15 watts maximum.

FREQUENCY RESPONSE: ± 0.1 db., 20 cps. to 20,000 cps.
± 2 db., 5 cps. to 100,000 cps.

POWER RESPONSE: 12.5 watts, ± 1 db., 10 cps. to 50,000 cps.

PHASE SHIFT: ± 15 degrees, 20 cps. to 20,000 cps.

TOTAL HARMONIC DISTORTION: Less than 0.1% at 10 watts at mid-freqs.

INTERMODULATION DISTORTION: Less than 0.5% at 10 watts (40 & 12,000 cps.: 4/1)

HUM AND NOISE LEVEL: 90 db. below rated output.

SENSITIVITY: 1.5 volts, rms. input for rated output.

OVERALL GAIN: 70 db. (470,000 ohm input resistance)

DAMPING FACTOR: 32:1

OUTPUT INTERNAL IMPEDANCE: 0.5 ohm on 16 ohm tap

OUTPUT LOAD IMPEDANCE: 8 and 16 ohms nominal

POWER CONSUMPTION: 105-125 volts, 60 cps., 125 watts

TUBE COMPLEMENT: 6SN7GTA amp. & inverter, 6SN7GTA push-pull driver, (2) KT66 power output, 5V4G rectifier.

OVERALL DIMENSIONS: 8 in. x 13½ in. x 7½ in. high

SHIPPING WEIGHT: 25 lbs.

UNPACKING:

As soon as the chassis has been unpacked, examine it for any apparent damage which might have occurred in shipment. Should any sign of damage be found, file a claim immediately with the carrier stating the extent of the damage.

Included with the chassis should be the following:

4	9MXAVL	#8-32 chassis mtg. screws
4	10N012	chassis mtg. flat washers
1	13X602	audio input plug (shipped in input socket)
1	7X405	2 conductor speaker cable

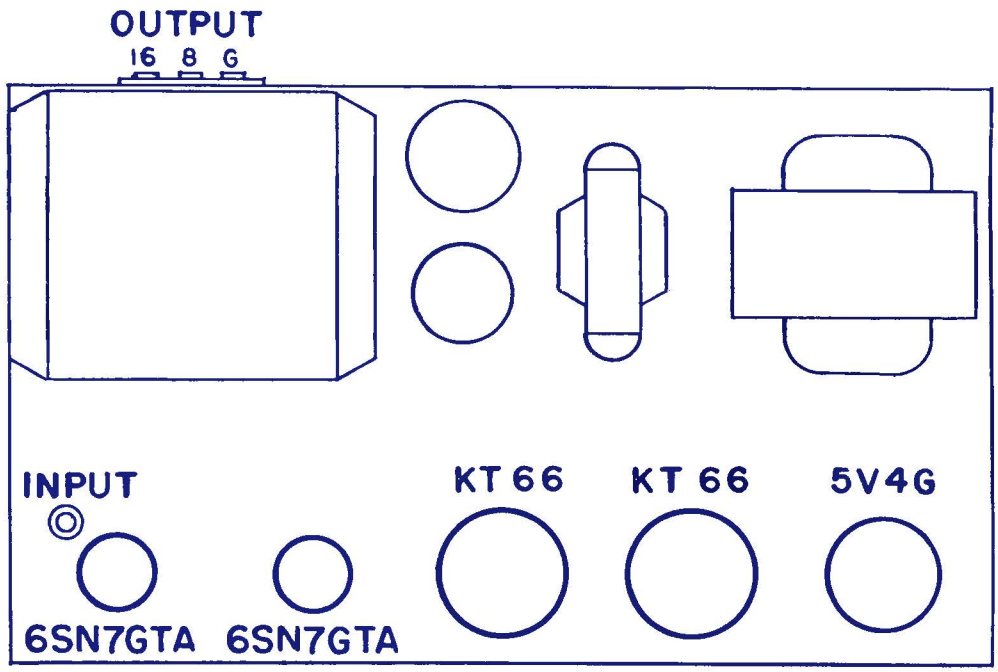
CABINET INSTALLATION:

The absence of any operating controls on the C500 power amplifier makes possible its mounting in a concealed location such as in the speaker compartment; however, consideration should be made for its ventilation and service accessibility.

To mount, drill four holes on 13" x 7¼" centers using a ⅜" diameter drill. The chassis is then installed by using the four screws and flat steel washers provided.

AUDIO OUTPUT CONNECTIONS:

Output connections have been provided for either an 8 or 16-ohm speaker voice-coil impedance, however because of the low internal source impedance of the C500, some variation from these values can be tolerated. Using the 2 conductor speaker cable provided, connect one end



C500 CHASSIS TOP VIEW

REPLACEMENT PARTS LIST

The tolerance of many of the components in the C500 has been held very closely to maintain operating performance that is exceptional. In replacing any of these components, observe carefully the complete specifications for that item as described below.

CAPACITORS

Part No.	Ref. No.	Description	
18S033	C5	40 μf - 40 μf, 500v., 8 μf - 8 μf, 400v.,	Electrolytic
18X310	C6	4 μf, 600v.	Oil Filled
CP10M4104M	C3, C4	0.1 μf ± 20%, 400v.	Tubular
CP10M2224M	C8	0.22 μf ± 20%, 200v.	Tubular
CP10M4474M	C1, C2	0.47 μf ± 20%, 400v.	Tubular
CM20A680J	C9	68 μμf ± 5%, 500v.	Mica
CM20A561J	C7	560 μμf ± 5%, 500v.	Mica

RESISTORS

RC20AE101K	R23, R24	100 Ω, 1/2w, ± 10%	Carbon
RC20AE391K	R10	390 Ω, 1/2w, ± 10%	Carbon
RC20AE102K	R15, R20	1K Ω, 1/2w, ± 10%	Carbon
RC20AE223K	R27	22K Ω, 1/2w, ± 10%	Carbon
RC20AE104K	R14, R19	100K Ω, 1/2w, ± 10%	Carbon
RC20AE474K	R8, R9, R1	470K Ω, 1/2w, ± 10%	Carbon
RC20AE272J	R26	2.7K Ω, 1/2w, ± 5%	Carbon
RC20AE472J	R28	4.7K Ω, 1/2w, ± 5%	Carbon
RC30AE101K	R16, R18	100 Ω. 1w, ± 10%	Carbon
RC30AE223K	R6	22K Ω, 1w, ± 10%	Carbon
RC30AE333K	R2	33K Ω, 1w, ± 10%	Carbon
RC30AE473K	R3	47K Ω, 1w, ± 10%	Carbon
RC30AE223KB	R5, R7	22K Ω, 1w, ± 10%, matched ± 1%	Carbon
RC40AE473KB	R11, R13	47K Ω, 2w, ± 10%, matched ± 1%	Carbon
RW0471J	R4	470 Ω, 1/2w, ± 5%	Wire-wound
RW5401GB	R21, R22	400 Ω, 5w, ± 2%, matched ± 1%	Wire-wound
23S801	R17	100 Ω, 2w,	Potentiometer
23S802	R25	100 Ω, 2w,	Potentiometer

TRANSFORMERS AND CHOKES

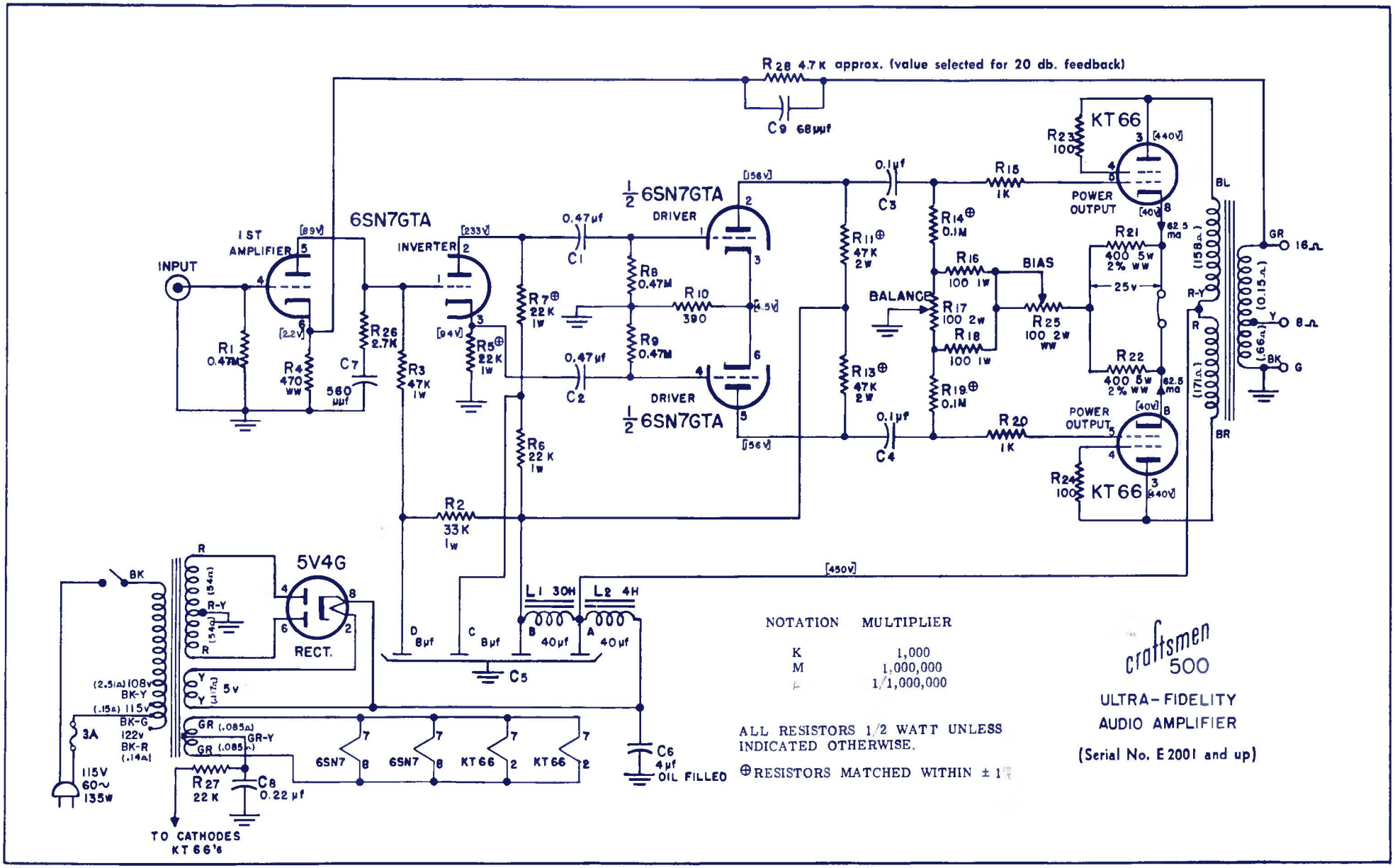
19S014	Audio Output Transformer (Available only on return of defective transformer)
19S212	Power Transformer
19S408A	Choke, 4H., 150 ma.
19S409	Choke, 25H., 20 ma.

TUBES

5V4G	Rectifier
6SN7GTA	Amplifier and Inverter, Driver
KT66	Output (Should be matched pair for optimum operation)

MISCELLANEOUS

4X010	Switch, AC
13X602	Audio Plug
34X003	Fuse, 3A, 250v.



NOTATION	MULTIPLIER
K	1,000
M	1,000,000
μ	1/1,000,000

ALL RESISTORS 1/2 WATT UNLESS INDICATED OTHERWISE.

⊕ RESISTORS MATCHED WITHIN ± 1%

craftsmen 500

ULTRA-FIDELITY AUDIO AMPLIFIER

(Serial No. E 2001 and up)

of each lead to the speaker voice-coil and the other end of each lead to the amplifier output terminals marked G (grounded inside the amplifier chassis) and the numbered tap most nearly corresponding to the speaker voice-coil impedance. Additional cable length may be added with no noticeable loss of power to approximately 50 ft. of #18 wire.

AUDIO INPUT CONNECTIONS:

The shielded amplifier input is located near the 1st 6SN7GT vacuum tube. It has a 470,000 ohm input resistor and therefore normally would not be used with tuner or other audio output source impedances greater than 220,000 ohms. Any volume control, frequency compensation, pre-amplification, or switching functions must be performed in chassis units preceeding the input to the C500. For length and type of audio interconnecting cable to be used, refer to the instructions accompanying the unit feeding the C500.

POWER SOURCE:

The C500 amplifier has been designed to operate from a 60 cps., 115-volt power source. Continuous operation at higher than rated line voltage will shorten the life of the output tube. Therefore in installations where the line voltage is 5 volts or more higher than 115 volts, the jumper lead to the terminal board on the chassis wall near the power transformer should be changed to the HIGH tap. For line voltages 5 volt or more low, move jumper to LOW terminal.

An OFF-ON power switch and 3 a. fuse have been provided for additional protection to the amplifier.

BALANCE AND BIAS ADJUSTMENT:

Both the BALANCE and BIAS adjustments have been set at the factory for correct operation. However, if at any time, it is found necessary to replace either output tube, it will be necessary to readjust these controls as follows:

Remove the BALANCE and BIAS nameplate.

Open one side of the link on the output cathode terminal board. Connect a DC voltmeter across the two terminals on this board. Adjust the BALANCE potentiometer for a zero reading on the voltmeter (use lowest voltmeter scale).

Now connect the + lead of the DC voltmeter to either terminal on the cathode link board and the — lead to the junction of the two 400 ohm, 10w. resistors (R21 and R22). Adjust the BIAS potentiometer until the meter reads 25 volts. The voltage to the other cathode terminal should also now read 25 volts. It not, repeat BALANCE operation.

Replace cathode link. Replace BALANCE and BIAS nameplate.

Although the BALANCE adjustment will accommodate a considerable unbalance between output tubes, pairs of tubes having similar triode operating characteristics, such as furnished by the factory, will give lower distortion and other performance benefits.

CAUTION:

Operation of the C500 with continuous output in excess of 15 watts will often seriously reduce the life of one or both of the output tubes. At no time should the amplifier be operated with only one output tube in place.

USE OF 5881 OUTPUT TUBES:

Although the socket connections and triode DC ratings of a 5881 make it interchangeable with the KT66 output tubes in the C500, amplifier performance will be found to vary in the following respects:

First, readjustment of both the BALANCE and BIAS adjustments is necessary as described previously in these instructions.

Secondly, the harmonic and intermodulation distortion will be found to increase rapidly beyond 8 watts with a maximum audio power output of 12 watts.

Finally, other C500 characteristics such as the output internal source impedance will be found to vary somewhat from those specified.

BASS RESPONSE WITH SPEAKER:

Despite the flat gain vs. frequency characteristics of the C500, loss of bass sound output might be observed with the use of some loudspeaker systems. This effect is due to the excellent damping action at the amplifier output. In spite of the obvious merits of good speaker damping, occasionally speaker systems have been designed to make use of less electrical damping action to hold up their bass response. Since a well-damped speaker system is always preferable, the speaker response should be compensated elsewhere in the system.

500 OHM SPEAKER OPERATION:

Although there is no 500 ohm output tap on the C500, this amplifier can be used with most speakers nominally listed as having 500 ohm impedance.

Since these speakers have low impedance voice coils coupled with 500 ohm matching transformers, they can readily be converted to the lower impedance by removing the matching transformer mounted on the speaker frame. For more complete information on converting a coaxial speaker such as a Jensen JHP-52 or JAP-60 series, contact the speaker manufacturer.

Service Department:
1617 SOUTH MICHIGAN AVE.
CHICAGO 16, ILLINOIS

THE RADIO CRAFTSMEN, INCORPORATED

Main Factory:
4401 NORTH RAVENSWOOD AVE.
CHICAGO 40, ILLINOIS

LITHO IN U.S.A.—3-52—21S436A

From the laboratories which brought you  the Craftsmen high fidelity FM-AM tuners and  television chassis...

...comes a new concept of amplifier performance in the Craftsmen 500...

...ULTRA FIDELITY

C500 SPECIFICATIONS

POWER OUTPUT: 15 watts maximum

FREQUENCY RESPONSE:
± 0.1 db., 20 cps. to 20,000 cps.
± 2 db., 5 cps. to 100,000 cps.

POWER RESPONSE: 12.5 watts, ± 1 db., 10 cps. to 50,000 cps.

PHASE SHIFT: ± 15 degrees, 20 cps. to 20,000 cps.

TOTAL HARMONIC DISTORTION: Less than 0.1% at 10 watts at mid-freqs.

INTERMODULATION DISTORTION: Less than 0.5% at 10 watts (40 & 12,000 cps.: 4/1)

HUM AND NOISE LEVEL: 90 db. below rated output.

SENSITIVITY: 1.5 volts, rms. input for rated output.

OVERALL GAIN: 70 db. (470,000 ohm input resistance)

DAMPING FACTOR: 32:1

OUTPUT INTERNAL IMPEDANCE: 0.5 ohm on 16 ohm tap

OUTPUT LOAD IMPEDANCE: 8 and 16 ohms nominal

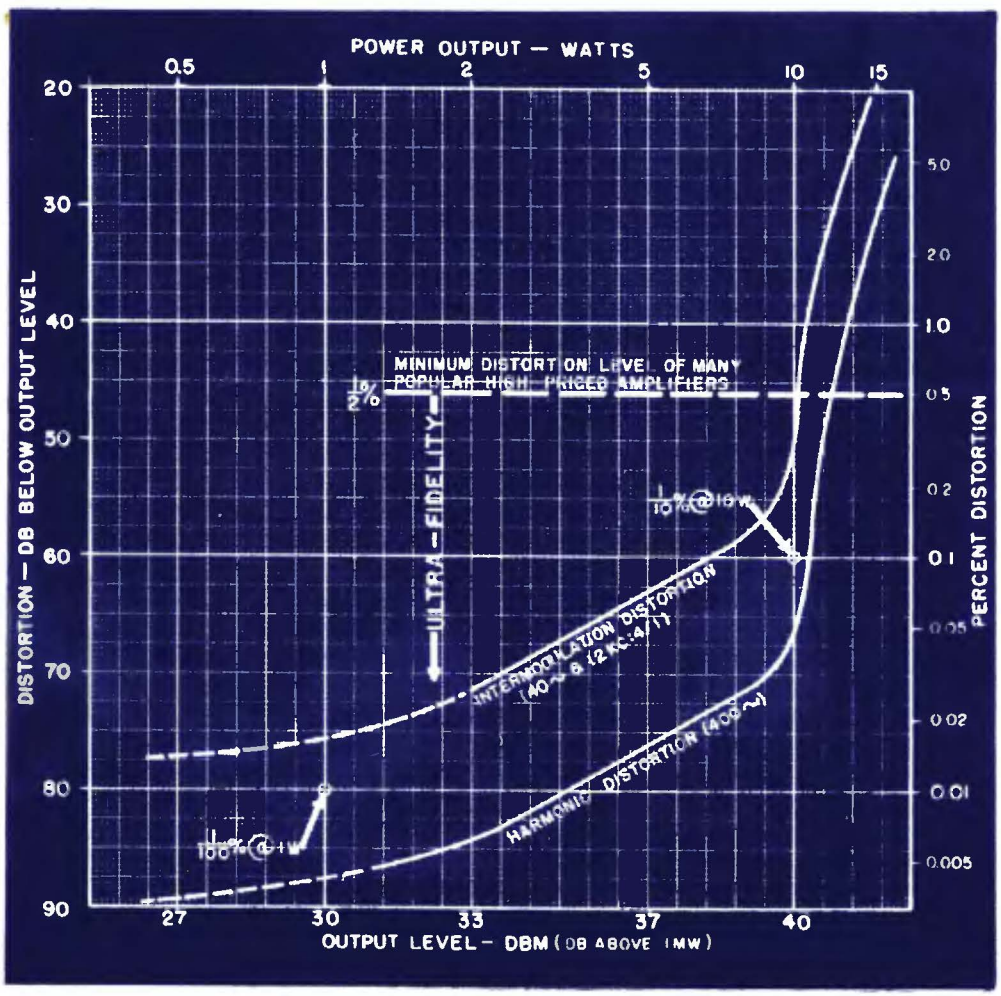
POWER CONSUMPTION: 105-125 volts, 60 cps., 125 watts

TUBE COMPLEMENT: 6SN7GTA amp, & inverter, 6SN7GTA push-pull driver, (2) KT66 power output, 5V4G rectifier.

OVERALL DIMENSIONS: 8 in. x 13½ in. x 7½ in. high

SHIPPING WEIGHT: 25 lbs.

CHASSIS: Finished in polished chromium.



HARMONIC and INTERMODULATION DISTORTION vs. POWER OUTPUT

DISTORTION AND POWER OUTPUT

Such unusually low distortion is attained in the Craftsmen 500 amplifier that it can be considered to approach the vanishing point—at normal listening levels below one watt, the total harmonic distortion is less than 1/100 percent. Although, seldom in the home are there required levels above one watt with modern high-efficiency speakers, the C500 has a reserve output capability of 10 watts average or 20 watts peak power with less than 1/10 percent harmonic distortion. This output is maintained with low harmonic distortion throughout the audio range so that the more critical measurement of intermodulation distortion using 40 and 12,000 cps. (4 to 1 ratio) is also remarkably low — ½ percent at 10 watts.

What is Ultra-fidelity?

Ultra-fidelity is a new concept in audio amplifier performance previously found only in the research laboratory. With an ultra-fidelity amplifier, harmonic and other types of distortion either approach the point of vanishing or are truly negligible over the entire range from 20 to 20,000 cps. In order to maintain excellence throughout this range, the complete frequency range of an ultra-fidelity amplifier must be considerably wider than the audio range. The Craftsmen 500 amplifier now brings ultra-fidelity from the research laboratory to the home.

ALL TRIODE CIRCUITRY

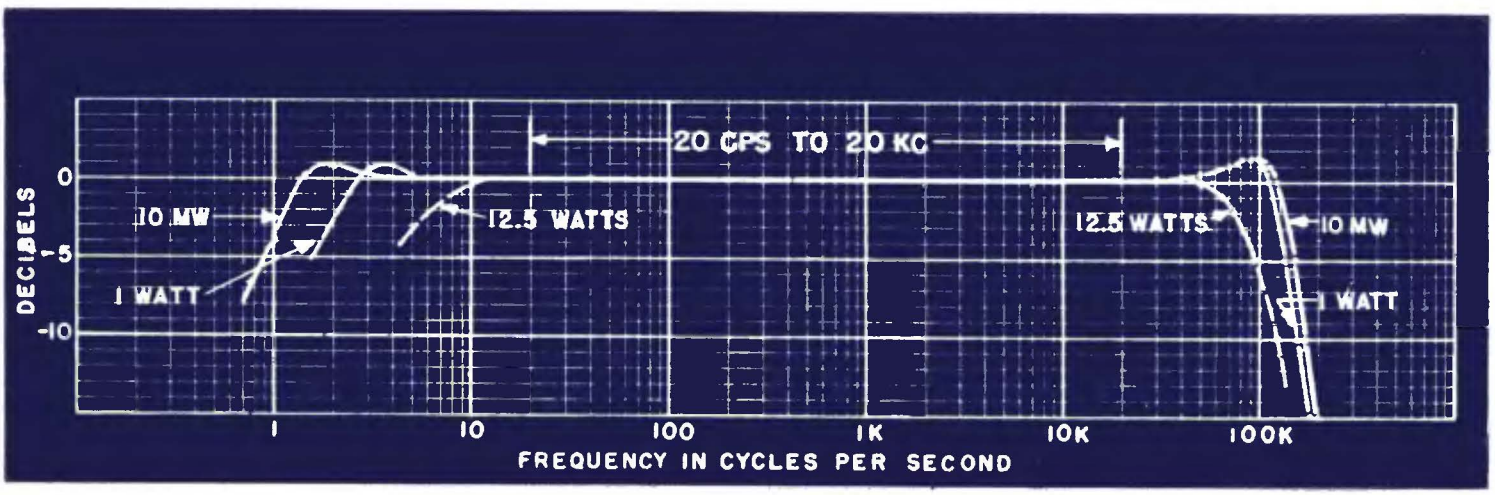
The Craftsmen 500 is based on the now-famous Williamson all-triode circuit which is exceptional in its basic simplicity. The circuit includes a direct-coupled, split-load phase inverter feeding triode drivers and class A operated triode output tubes, which even without feedback provide the characteristics of an extremely high-fidelity amplifier. These characteristics include the oft-cited merits of triodes operating in class A (such as low-distortion, low output impedance, and non-critical operating characteristics), qualities difficult to duplicate with pentode systems. All these characteristics are then further improved by the application of 20 db. of inverse feedback around the entire amplifier from output to input.

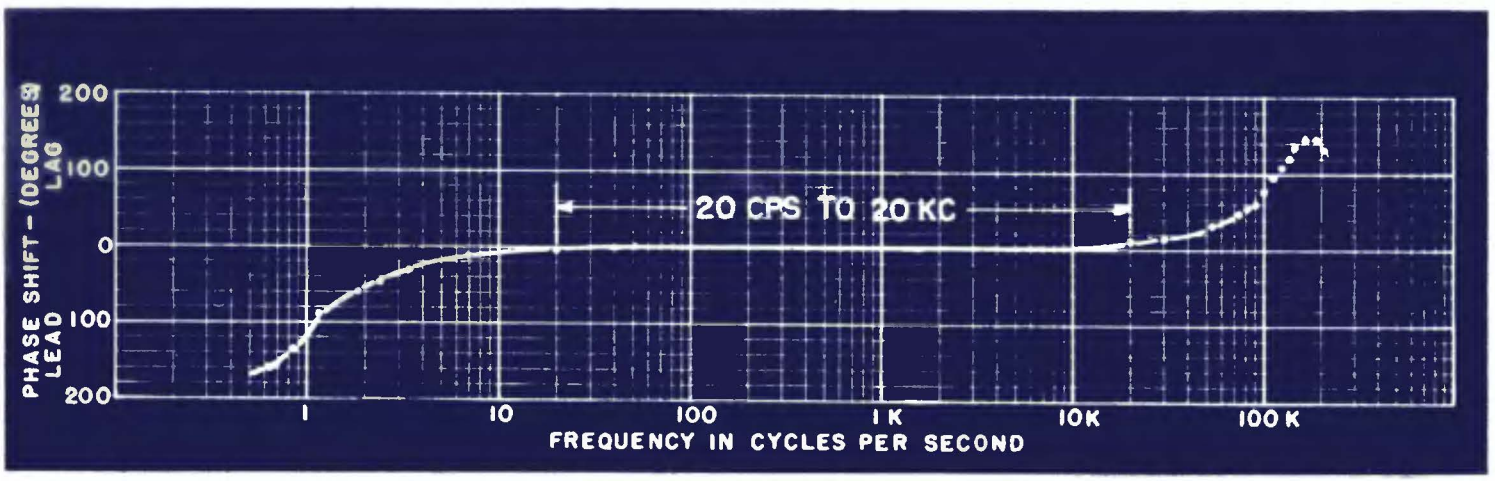
Why do you want Ultra-fidelity?

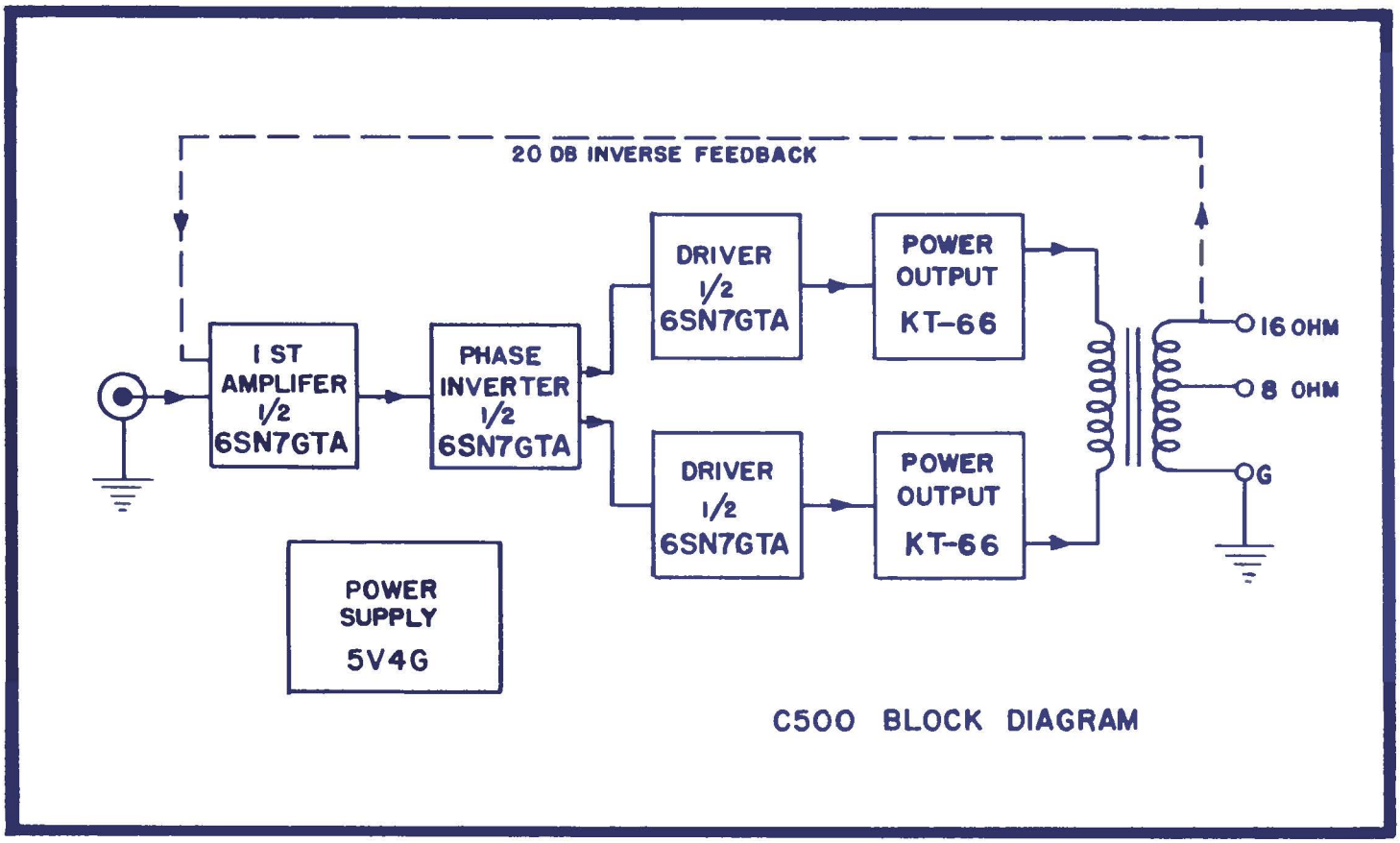
The use of an ultra-fidelity amplifier eliminates completely the audio power amplifier from being a source of distortion in a home music system. In addition to this, an ultra-fidelity amplifier, because of its excellent damping characteristics, can reduce transient distortions in the speaker system. These outstanding performance characteristics may be clearly and practically demonstrated to the listener by providing low listening fatigue and by recreating an intangible effect of "presence" approaching concert-hall realism.

FREQUENCY RESPONSE

In order to maintain the amplifying response flat within ± 1/10 db. throughout the audio range of 20 to 20,000 cps., it is necessary to control carefully the response below 5 cps., and above 100,000 cps., as shown in the accompanying diagrams. Use of an excellent output transformer maintains this flat response within ± 1 db., from 10 to 50,000 cps., even under a load of 12 watts. Audio experts are familiar with the practice of using amplifiers with higher mid-frequency ratings to procure acceptable undistorted power output over the low bass and high treble ranges. Because the C500 delivers full output over the entire audio range, the above practice is unnecessary and the C500 rating is considered more than adequate as listening tests have aptly demonstrated.



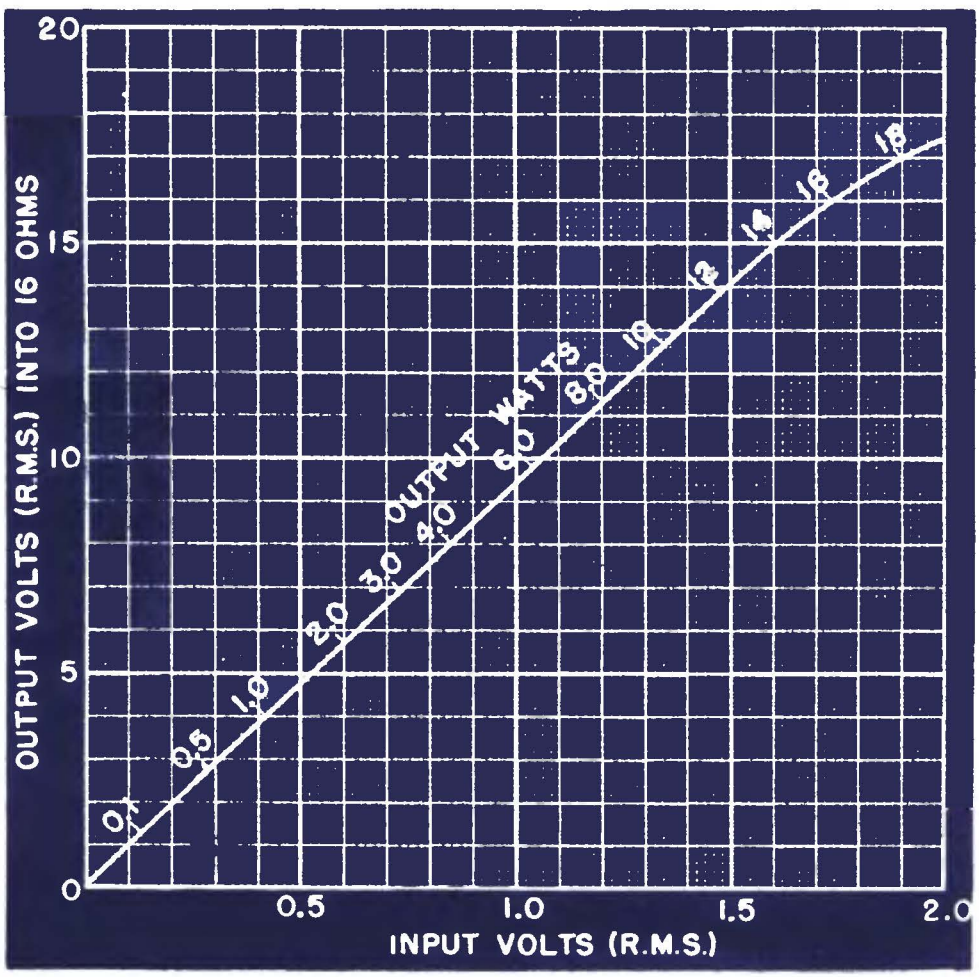




C500 BLOCK DIAGRAM

PHASE RESPONSE AND TRANSIENT RESPONSE

Since an analysis of the wave-shapes encountered in music and speech shows a preponderance of sharply peaked and steep-sided wave fronts, high-fidelity audio equipment must be capable of duplicating these wave-shapes faithfully and without originating additional transient signals. This important characteristic of audio equipment is generally tested in the laboratory by checking its reproduction of square waves. Excellent square-wave response has been accomplished in the C500 by following video amplifier design techniques which require an excellent phase response characteristic as well as a good frequency response far beyond the audio spectrum. In this amplifier, the excellent phase response showing less than 15 degrees shift at the extremes of the audio range has made possible almost perfect duplication of square-waves as low as 20 cps. or as high as 20,000 cps. with practically no transient tails or ringing that might mar musical reproduction.



C500 SENSITIVITY

ULTRA CRAFTSMEN FIDELITY 500

OUTPUT LOAD DAMPING AND MATCHING

Even though an audio amplifier may perform well in laboratory tests with a fixed resistive load, of much greater importance is its performance with a typical loud speaker load which not only exhibits impedance variations but also capacitive and inductive effects. Under these conditions, the advantages of triodes over pentodes become apparent since they inherently are less critical to these load variations and can operate near full output with either capacitive or inductive loads without distorting. These characteristics are further improved with the use of inverse feedback as shown by the very low output internal impedance of 0.5 ohm on the 16 ohm tap, equivalent to a damping factor of 32:1.

This low output impedance means that the amplifier is effectively a short circuit to any transient distortions in the speaker. The listener experiences this action as a fresh new sensation of clarity with an appreciable reduction in "speaker hangover" and "muddiness" often exhibited by sound systems.

Furthermore, the amplifier acts as a constant-voltage generator at the output terminals thereby reducing the importance of matching the load impedance (8 or 16 ohms, nominal) accurately.

INVERSE FEEDBACK

The use of 20 db. inverse feedback from the output to input of the C500 besides contributing as much as 10 to 1 reduction in harmonic distortion, output internal impedance, hum and noise, and phase and frequency distortion, furnishes other valuable effects as well. These include the stabilization of the amplifier by reducing the effects of variations in supply-voltage and tube operating characteristics.

One might question why other audio amplifier designs have not made use of such a powerful tool as inverse feedback to the degree used in the C500. Briefly, the application of 20 db. of inverse feedback must be controlled extremely carefully, not only over the entire audio range, but from ½ cps. to beyond 2 mc. to insure conservative stability margins. Specialized and extensive engineering facilities are usually required to carry out the design of wide-range feedback amplifiers in order to insure that there are no tendencies toward instability caused by uncontrolled feedback even with unusual load conditions. For this reason, great care has been taken particularly in the design of the output transformer and also in the selection of other components. Each amplifier is carefully checked to insure at least 30-degree phase and 10 db. gain stability margins, thus eliminating any uncertainty about the amplifier performance.

HUM AND NOISE LEVEL. In a high-fidelity system where the aim is to reproduce sound indistinguishable from the original, any added distortions or disturbing elements cannot be tolerated—thus hum and noise must be reduced to the vanishing point. In the C500 the hum and noise level of 90 db. below rated output is several times lower than that currently found in high-fidelity practice. This low level is made possible not only by careful design but also by the use of inverse feedback around the entire amplifier.

COMPONENTS AND TESTING. The amazing performance of this amplifier has not been accomplished without particular attention being given to the choice of components. The selection of KT66 output tubes is similar to that utilized in the original Williamson amplifier. These tubes not only have higher triode power output capabilities in this application than 807's, 6L6's, and other tubes that are popularly being used, but also exhibit a lower plate impedance so important to the C500 features. Adjustments are provided for setting accurately both the bias and balance of the output stage to obtain optimum operation of the KT66's. In addition, each KT66 is pretested and pairs are selected for balanced operation.

The output transformer is one of the finest available and features interleaved windings, 25 mh. leakage inductance, 120 h. primary inductance, full power output from 10 to 50,000 cps., and is fully potted in a steel case. Other components were selected with equal care for long life, using only plastic-molded paper coupling capacitors, a hermetically-sealed oil-filled input filter capacitor, and a polished chromium-plated chassis.

Finally, each chassis is thoroughly inspected and tested to meet fully various performance tests in addition to the published electrical specifications.

INSTALLATION. The C500 has been designed primarily to be used as a separate audio power amplifier unit. It can conveniently be used in a hidden installation. Any volume control, frequency compensation, pre-amplification, or switching functions should be performed in chassis units preceeding the input to the C500. Such control functions are found in the Craftsmen FM-AM tuner, television tuner, and also in a separate control and pre-amplifier unit to be announced soon.

THE RADIO craftsmen INCORPORATED

4401 N. RAVENSWOOD AVE.

CHICAGO 40, ILLINOIS

21S211—10-51

INSTALLATION *and* SERVICE BULLETIN

SUBJECT: C-500 AMPLIFIER WITH 500-IMPEDANCE SPEAKERS.

THE RADIO craftsmen INCORPORATED
4401 N. RAVENSWOOD AVE.
CHICAGO 40, ILLINOIS

In the past some manufacturers have designed their speakers with 500 ohm impedances. This practice was directly attributed to the method used by broadcast engineers. The technical reasons for this are beyond the scope of this discussion.

The present tendency in the electronic field is to do away with 500 ohm impedance speakers.

When confronted with using a C-500 or a C-2 amplifier with a 500 ohm impedance speaker, (since there is no 500 ohm output impedance of a C-500 amplifier), it should be stated that the manufacturers have published technical notes for converting their speakers into 16 ohm or 8 ohm impedance speakers.

The most common of these are the Jensen JHP-52 and JAP-60 series. Complete conversion plans can be had by writing the Jensen Mfg. Co. and requesting the Technical Notes JTN-1 and JTN-2a. The conversion is simple in nature and will not cause any difficulty.

In no way should it be recommended to insert a matching line transformer in between the C-500 or C-2 amplifier and the speaker. This additional amount of iron will hinder the response.

October 1, 1951

DEALER PRICE LIST

CRAFTSMEN HI-FIDELITY CHASSIS

	DEALER	LIST
Craftsmen 2	$ 42.90	$ 71.65
Craftsmen 10	131.50	219.00
Craftsmen 101 (Turret Tuner)	242.10	321.95
Craftsmen 200 (Continuous Tuner)	252.50	336.80
Craftsmen 201 (Turret Tuner)	252.50	336.80
Craftsmen 500	99.50	166.00
KT66 Vacuum Tube (Pr. Selected and Matched)	11.50 pr.	19.20 pr.
Kit 217R*	15.40	20.60
Kit 220R**	21.40	28.45
Kit 224M†	42.50	56.80

TV Chassis prices are less picture tube. All prices include 10% Federal Excise Tax.

*For use with 17AP4, or 17BP4 rectangular tube.
**For use with 20CP4, or 20DP4 rectangular tube.
†For use with 24AP4 metal round tube.

21S212—10-51

Prices subject to change without notice.

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