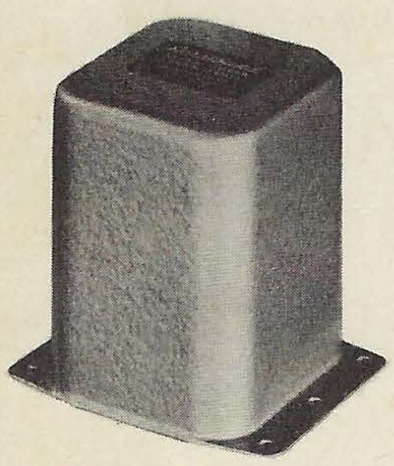
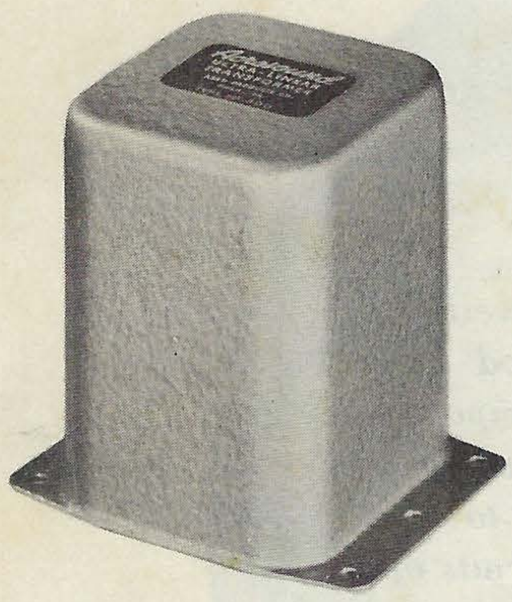
For the finest sound . . .

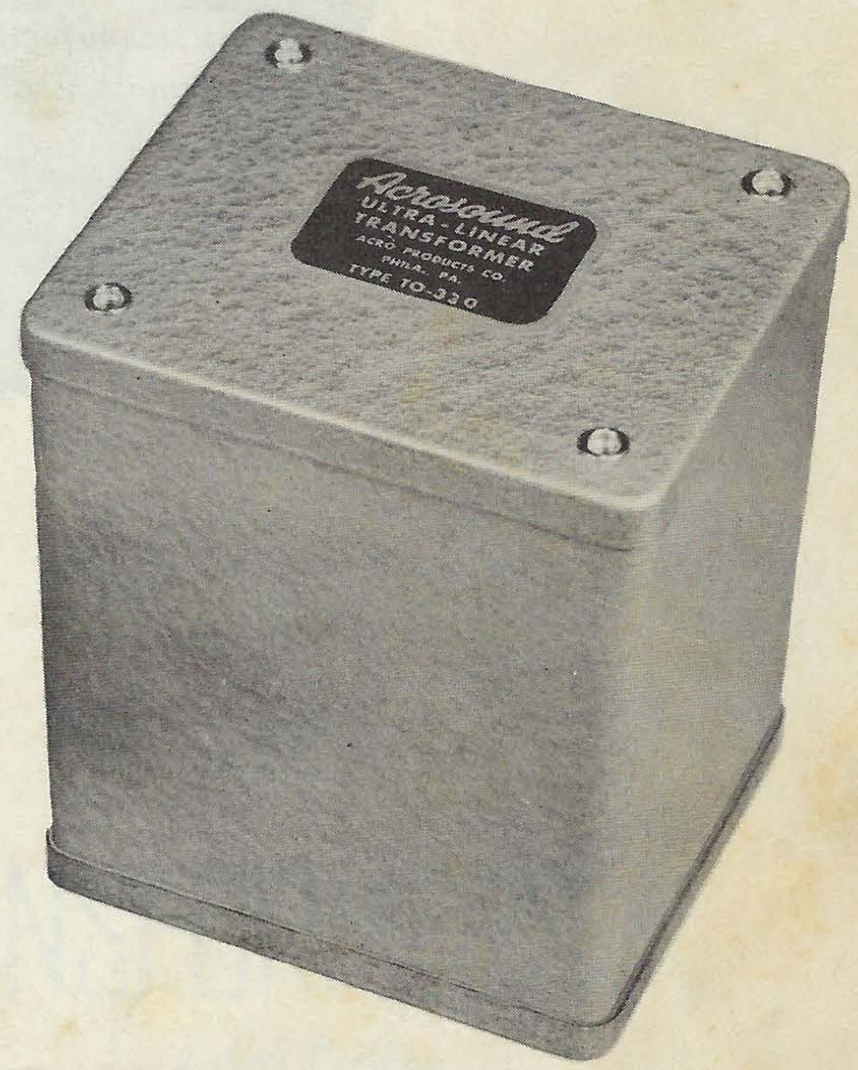
Acrosound ★



Ultra-Linear* Output Transformers*



Radio-TV Supplies, Inc.
1411 Main Street
Jacksonville 6. Florida
Phone 3-7353



*Patent Pending

ACRO PRODUCTS CO.
369 SHURS LANE, PHILA. 28, PA.

ACRO PRODUCTS COMPANY

Founded in 1949, Acro Products Company is one of the newest companies in the transformer field. However, in this short period it has achieved a fine reputation as a producer of high quality components. ACROSOUND output transformers, which are described in this pamphlet, have practically eliminated the shortcomings once attributed to audio transformers; and these transformers in properly designed circuits offer new standards of sound reproduction.

ACROSOUND output transformers are available nationally through electronics parts distributors. In addition to output transformers, Acro specializes in difficult designs and can supply specialty components to order for manufacturers who require non-standard power, pulse, or audio units of small size, wide band, low distortion characteristics.

ACROSOUND OUTPUT TRANSFORMERS

The design of an output transformer consists of a series of compromises. The factors which contribute to good low frequency response are detrimental to high frequency response and vice versa. The reduction of distortion may be incompatible with a broad bandwidth. In addition, of course, the quality and quantity of material and the complexity of construction are correlated directly with cost. In order to arrive at an optimum design, it is necessary to consider the end use of the transformer and to design with this in mind.

If the ultimate use of the transformer is in a high quality amplifier circuit, the designer must consider factors which influence frequency response, distortion at various frequencies at both high and low levels, and phase shift characteristics and weigh all of these against cost. Some of the factors involved include: transformer parameters of shunt inductance, leakage inductance, and capacitance; type, shape, weight, and lamination thickness of core material; and even the tube types to be used must be considered since their impedance influences performance with a given transformer.

The geometric construction of the coil must be such that coupling is good both from primary to secondary and from primary half to primary half. The first consideration influences high frequency response—the second influences high frequency distortion. Obviously, if the coupling between primaries is loose at any frequencies, the distortion reducing benefits of push pull operation do not apply; and distortion increases at those frequencies. Similarly, the ac balance of the two halves must be accurate, and the phase relationship must be held at 180 degrees or distortion will be increased.

The core material used influences both low frequency response and low frequency distortion. The permeability of the core is correlated with the low frequency response characteristic as it is one of the factors controlling the primary inductance. At low excitation levels, the inductance will decrease, and the response of the transformer will fall off as compared with high excitation levels. Transformers should be designed to meet specifications at *low* levels rather than high so that the purchaser can be assured of the promised performance at *all* levels.

The type and quantity of core material contribute to both high and low level distortion. A large core of poor material may handle as much total power as a small core of better material, but its low level distortion will be much higher. The large size transformer is not necessarily the better one—size is no measure of performance since the quality of the core, its quantity, and its shape all enter the picture. The best all around compromise seems to involve a moderate size transformer with special types of core material which have been made available in recent years.

Even a low distortion wide bandpass arrangement does not insure optimum transformer performance. The bandpass must be smooth, free of resonances, and with minimum phase shift over a very wide band. These characteristics are required for the effective use of feedback in the associated circuitry. Modern amplifier designs utilize feedback for all circuits where high quality is desired. Therefore, the transformer designer must design with the anticipation that the unit will be used in a feedback configuration.

All of these conflicting factors have been weighed with care in the design of ACROSOUND output transformers. The "200" series for conventional circuitry and the "300" series for Ultra-Linear circuitry combine the most desirable and important transformer characteristics into a compact and modestly priced unit of superior performance capabilities. These units have been designed with the goal of producing better audio amplification. For the ultimate consumer who listens to musical reproduction in his home, they are intended to produce the finest quality sound available.

ACROSOUND "200" SERIES TRANSFORMERS

The "200" series transformers are designed for the most popular type high quality circuits of standard configuration. These units are low in cost compared to competitive high quality units, but their performance is second to none. For example, they are conservatively rated and can be used with no difficulty in applications requiring *double* the nominally rated power. The frequency response characteristic is wider than many consider necessary for audio reproduction, but this additional bandwidth is associated with lower distortion and smoother phase characteristic within the 20 cps to 20 kc band; and therefore, is not just an unimportant frill.

Specifications and Performance Data

12.5 watt units

Model	Primary Impedance	Net Price	Recommended Tube Types
TO-250	5,000 ohms	$11.75	6B4's, 2A3's, 6AS7G 6L6 (class A)
TO-270	10,000 ohms	$11.75	6V6's, 6AQ5

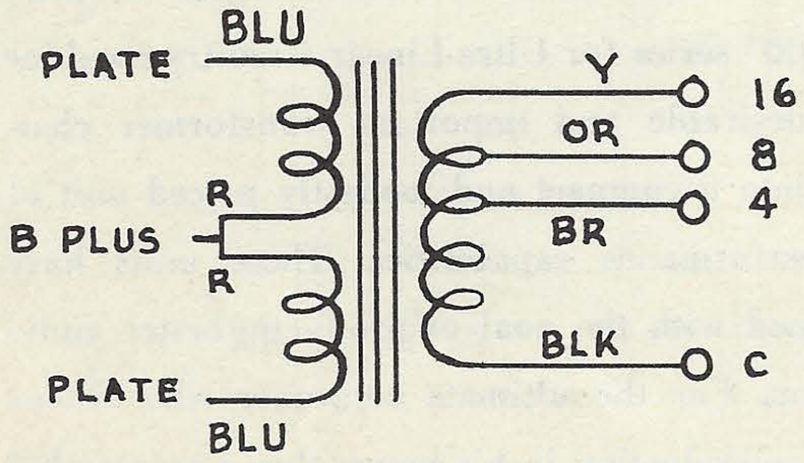
20 watt units

TO-230	3,000 ohms	$14.50	6B4's or 2A3's (fixed bias), pp par 6L6's (class A)
TO-280	9,000 ohms	$14.50	6L6's (class AB1 self bias)
TO-290	12,000 ohms	$15.75	807's, 5881's, or KT-66's as triodes in Williamson circuit

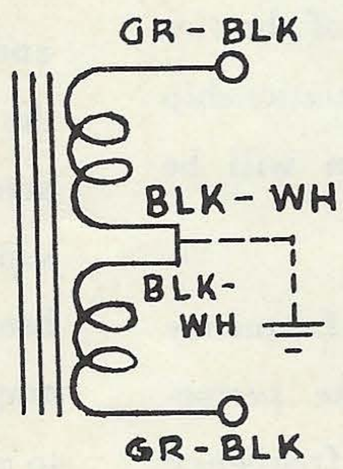
Guaranteed frequency response	± 1 db 10 cps to 40 kc
Power response	± 1 db 20 cps to 20 kc
Ratio primary inductance to leakage reactance	4,000 to 1
Maximum dc per half primary	75 ma (except 150 ma for TO-230)
ac primary unbalance	1% max.
Secondary impedances*	4, 8, or 16 ohms from tapped winding
Permissible feedback	25 db
Size**	3⅝" x 3¼" x 4¼" high
Base with flange	3⅝" x 4½"

*Also available with *added* 125 and 500 ohm secondary winding at $6.00 additional net cost. Model numbers for units with extra 500 ohm winding end with numeral "5." For example, the TO-290 with added 125 and 500 ohm winding is designated TO-295.

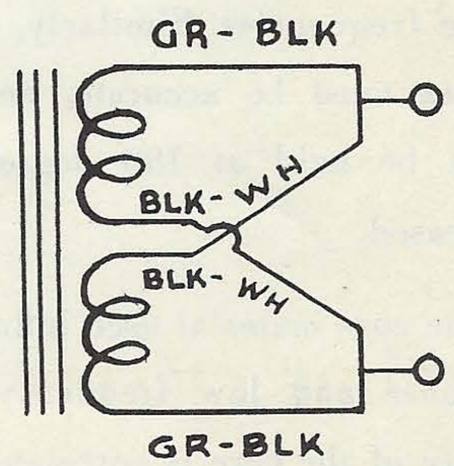
**All units are fully potted in seamless steel case with gray hammertone finish. Connections are brought out as 10 inch flexible insulated wire leads with color coding.



CONNECTIONS FOR "200" SERIES



CONNECTIONS FOR 500 OHMS



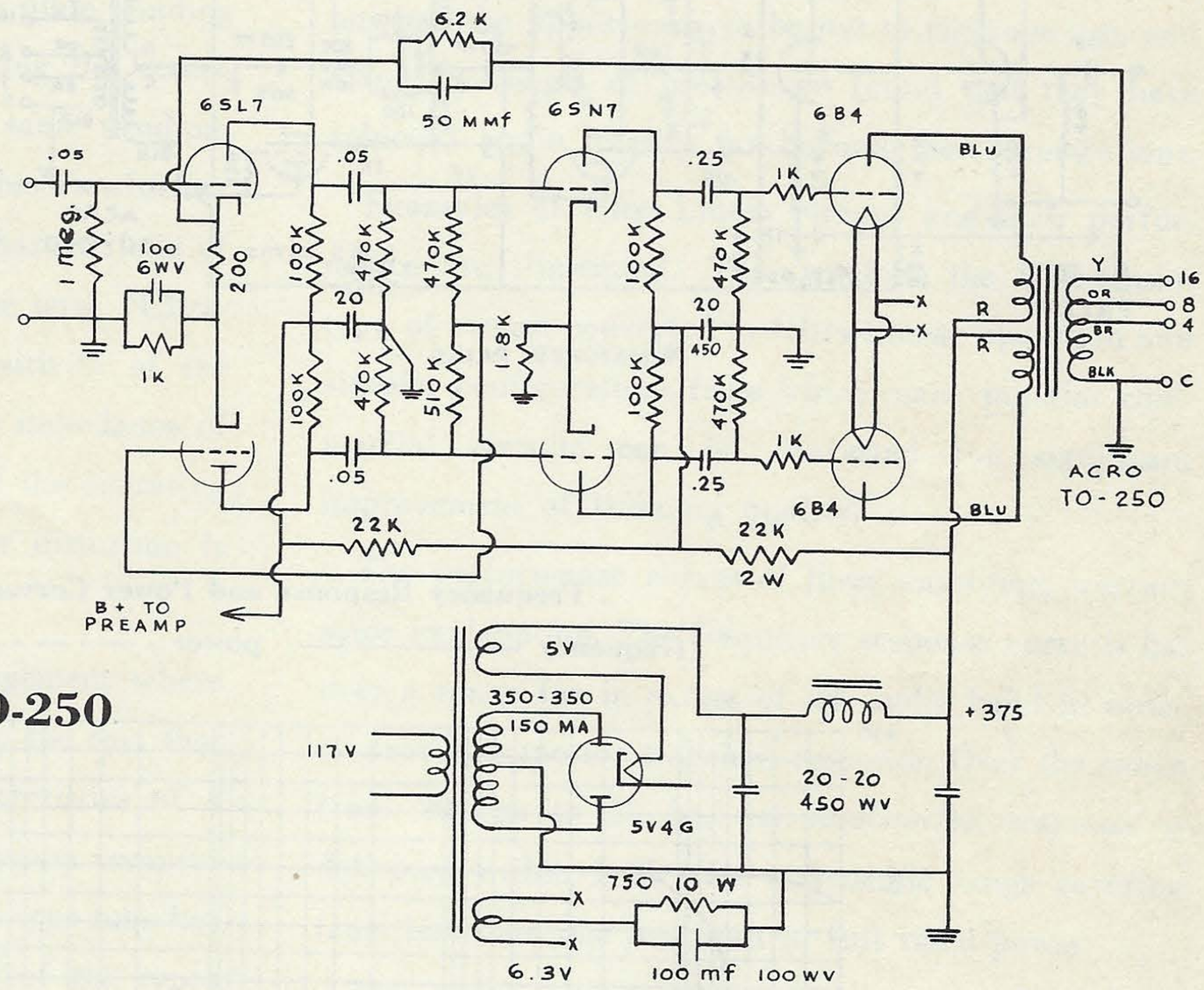
CONNECTIONS FOR 125 OHMS

Some typical circuits which have been found very satisfactory with ACROSOUND output transformers are shown below. Naturally, any good circuit can be used as well, and these are given as examples of trouble-free arrangements of excellent quality. These amplifiers are audibly clean and smooth due to low distortion, exceptionally wide frequency response, and excellent transient characteristics.

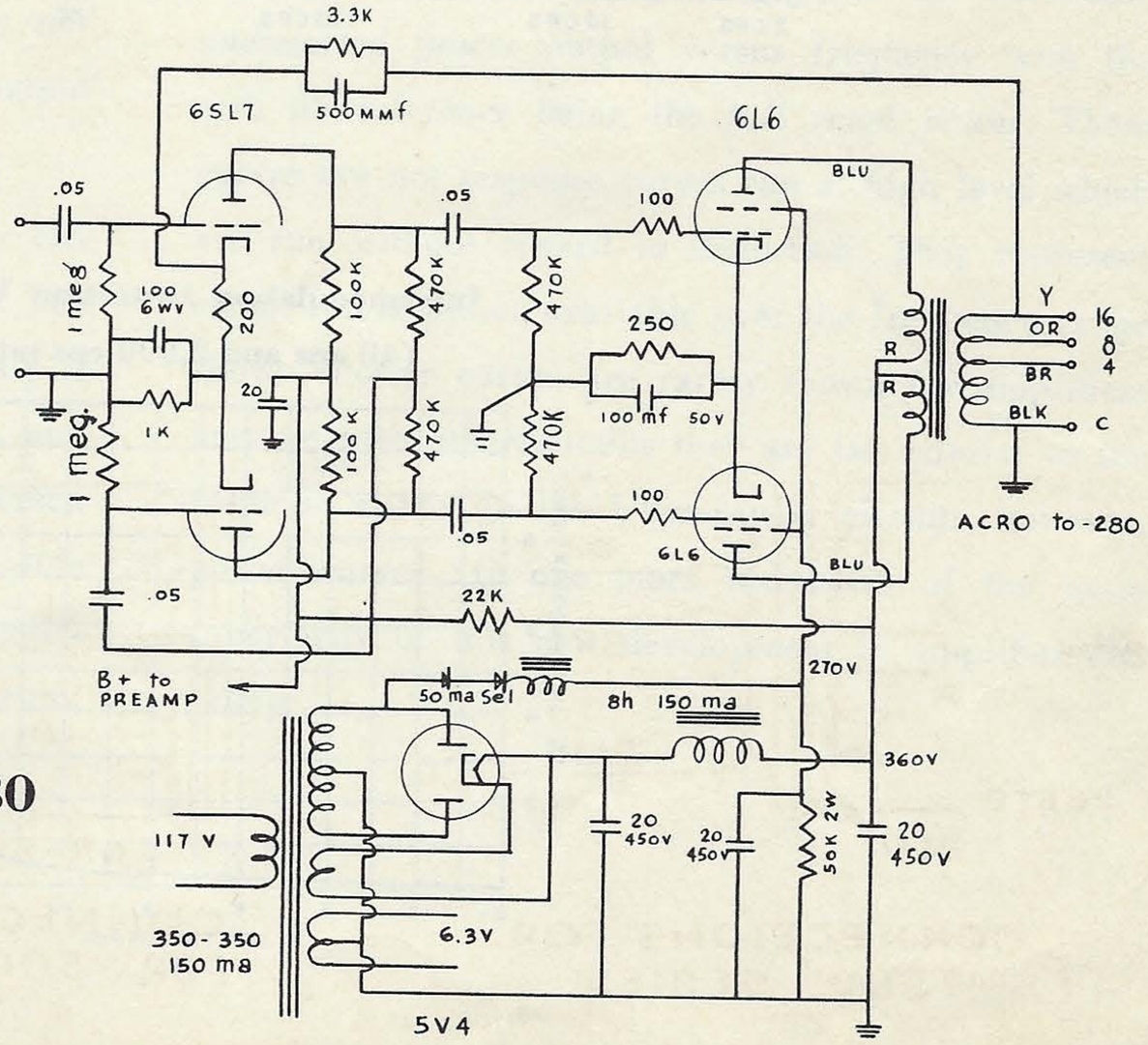
One circuit uses the ever popular triode tube with the additional circuit refinement of degenerative feedback. Any of the 2A3 family of tubes (6B4, 6A5G, 6A3) can be used providing the basing and/or filament arrangements are changed accordingly. The circuit supplies 10 watts of clean output.

The other circuit is a beam tetrode circuit utilizing 6L6's or 5881's. An output of 24 watts is obtainable at low distortion due to the unique and simple method of obtaining a well regulated low impedance screen supply. Such a supply is a requisite of tetrode operation if rated power is desired. Again, feedback is used to provide its usual benefits.

TRIODE CIRCUIT WITH TO-250

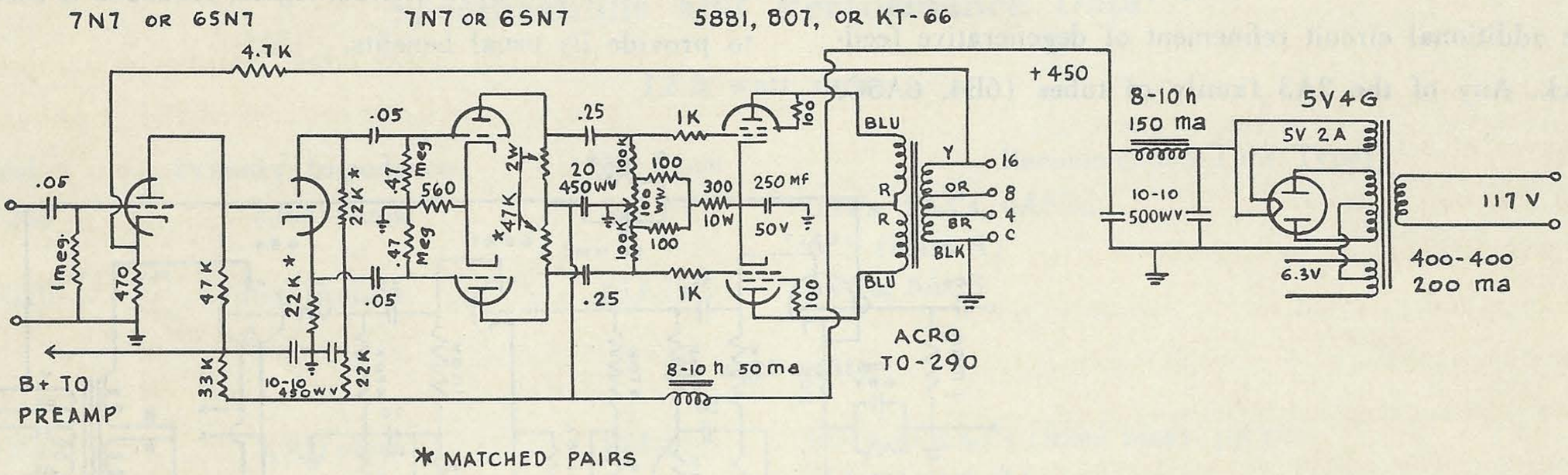


TETRODE CIRCUIT WITH TO-280



THE ACROSOUND ADAPTATION OF THE WILLIAMSON CIRCUIT

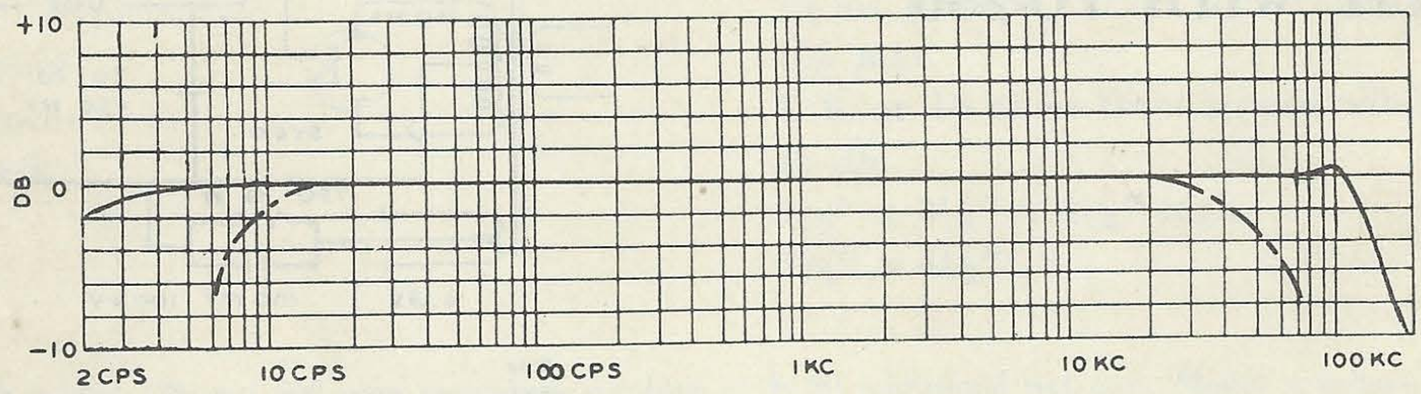
The ACROSOUND TO-290 transformer was designed to be utilized in the world famous Williamson circuit's American adaptation. This version, described in RADIO & TELEVISION NEWS, December, 1950, has been used widely both in this country and abroad with considerable enthusiasm. It offered, possibly for the first time, a circuit which the home constructor could build without difficulty and with modest cost which surpassed the commercial equipment available at the time. The circuit's success is based on a low distortion wide band arrangement with an excellent output transformer. Its performance is illustrated below and its quality is evident from the curves.



* MATCHED PAIRS

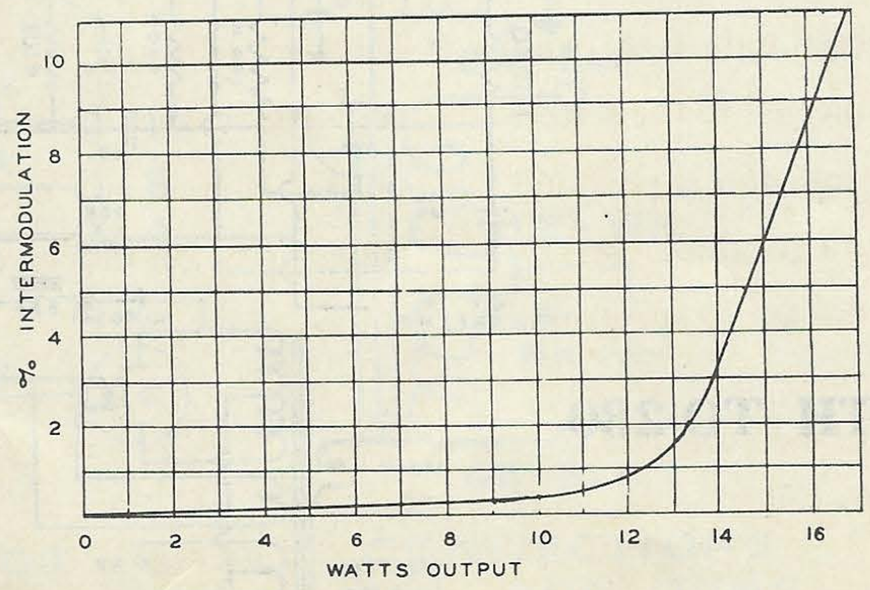
Frequency Response and Power Curves

(frequency ———— power - — - — - — - —)



Intermodulation Distortion Versus Power

(40 cps and 2,000 cps mixed 4:1)



ULTRA-LINEAR CIRCUITRY

Ultra-Linear circuits are the exclusive development of Acro Products Company, and patents are pending on this unique and novel method of linearizing the power output stage. The principles of Ultra-Linear operation have been described in some detail,* but a brief description may be of value to those who are unfamiliar with the arrangement.

In its most direct and simple arrangement, Ultra-Linear tube operation is obtained by connecting the screen of a tetrode tube to a tap on the plate winding of the output transformer thus energizing the screen grid with both dc and ac through the same winding. Screen and plate currents combine in the transformer in such a way that the dynamic plate characteristic of the tube is made more linear—hence the term "Ultra-Linear." The efficiency and power sensitivity of the tetrode are maintained; the low internal impedance of the triode is preserved; and over most of the operating range the intermodulation and harmonic distortion is less than for either triode or tetrode.

The Ultra-Linear circuit is an arrangement where something is achieved for nothing due to the fact that the method of operation has the characteristics of a new tube type which has effected an optimum compromise between triode and tetrode. This new type tube has a more linear characteristic than either of the types from which it is bred, and neither the triode nor tetrode can surpass it for quality as an audio output stage.

The transformer to be used in the Ultra-Linear circuit is somewhat critical in its characteristics. The distortion reducing characteristics are achieved only if the coupling of the primaries is exceedingly tight, and the coupling between the sections connected to the screen grids must be equally effective far into the supersonic regions. Otherwise the connection will produce oscillations in the frequencies far outside the audio spectrum.

Several special transformers have been designed specifically for use in Ultra-Linear circuits. These transformers represent a new forward step in the art of transformer design, and in conjunction with the Ultra-Linear circuits they permit the design of amplifiers with measurable and audible superiority over designs produced in the past.

Thus, the Ultra-Linear circuit consists of a superior circuit plus a superior transformer. The combination has had the opportunity to be put to rigorous test, and many thousands of users have found that they have achieved audio quality far beyond their expectations.

Examples of Ultra-Linear circuits and their performance are illustrated. These include the Williamson type of circuit converted to Ultra-Linear operation and simpler configurations from which many popular commercial circuits can be converted for significant improvement of listening quality.

The performance curves of these amplifiers warrant some explanation. The frequency response curve is flat over a range far in excess of the audio band in order to provide superior transient response. Over the range from 20 cps to 20 kc, flat *undistorted* response is delivered within 1 db over a dynamic range covering from less than one milliwatt to full rated power.

The power curves shown represent the *maximum undistorted power* output versus frequency with the zero db reference being the *full rated power*. These curves are not response curves run at high level which are run without regard to distortion. They represent *clean* usable power available over the frequency range shown. Power curves are rarely shown for amplifiers because with other circuits they are far inferior to the response curve. In the Ultra-Linear circuits, however, power curves are one more indication of the basic superiority of this new development in amplifier circuitry.

*AUDIO ENGINEERING, November 1951 and June 1952.
RADIO & TELEVISION NEWS, February, 1953

ACROSOUND "300" SERIES TRANSFORMERS
(tapped for use in Ultra-Linear Circuits)

"300" series transformers are specifically designed to obtain the maximum benefits of Ultra-Linear circuits. They impose practically no limitation on the quality of the associated circuit; and results obtainable are limited only by the inherent characteristics of vacuum tubes. These Ultra-Linear transformers have unequalled characteristics of frequency, power, distortion, and transient response and are fitting accessories to Ultra-Linear circuit arrangements. Their unique seven section concentric symmetrical coil structure is covered by patent claims which are pending. The taps are brought out at the optimum points for correct operation of the recommended tube types.

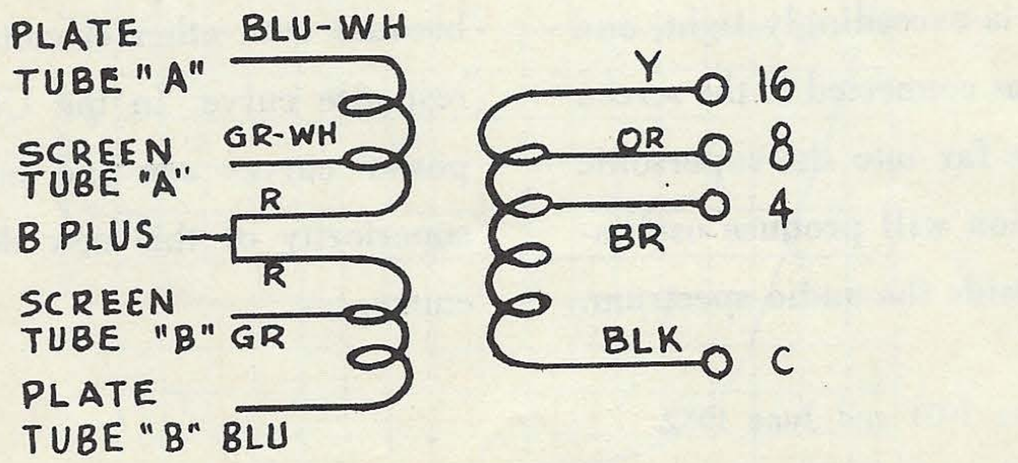
SPECIFICATIONS AND PERFORMANCE DATA

	TO-300	TO-310	TO-330	TO-350
Impedance	6600 ohms: 4, 8, 16*	8000 ohms: 4, 8, 16*	3300 ohms: 4, 8, 16‡	Available in 1954
Undistorted power— 20 cps to 30 kc	20 watts	10 watts	The TO-330 is designed for push pull parallel Ultra-Linear operation. Its operating parameters are proportional to those of the TO-300 transformer and in addition it carries a 50 watt power rating at 20 cps and will handle up to 100 watts at frequencies above 30 cps.	The TO-350 is designed for Ultra-Linear operation of type 6146 tubes. Its characteristics are similar to the TO-300 up to 100 watts.
Undistorted power— 30 cps to 20 kc	40 watts	20 watts		
Frequency response	± 1 db 10 cps to 100 kc	± 1 db 10 cps to 100 kc		
Permissible feedback	30 db	30 db		
ac primary unbalance	1% max.	1% max.		
Leakage reactance 1000 cps, referred to primary	8.5 mh	9.5 mh		
Leakage reactance 1000 cps, between primaries	8.5 mh	9.5 mh		
Primary shunt inductance	150 henries min.	85 henries min.		
High excitation primary inductance	600 henries	340 henries		
Insertion loss all taps	.75 db max.	.75 db max.	.5 db max.	
Max dc per primary	75 ma	75 ma	150 ma	
Permissible dc unbalance	15%	15%	15%	
Weight	6 lbs.	5 lbs.	15 lbs.	
Size**	3⅝" x 3¼" x 4¼" high	3⅝" x 3¼" x 4¼" high	4"x 4⅝"x5¼" high	
Base with flange	3⅝" x 4½"	3⅝" x 4½"	no flange - 3"x 3⅝" mtg centers	
Net Price	$24.75	$18.75	$39.75	

*Also available with *added* 125 and 500 ohm secondary winding at $6.00 additional net cost. Refer to "200" series for model designations and connection data.

‡ TO-330 and TO-350 have *either* voice coil (4, 8 and 16 ohms) or line (125 or 500 ohms) windings.

**The TO-300 and TO-310 are fully protected in seamless steel flanged cases with gray hammertone finish. The TO-330 and TO-350 are potted in folded steel cases with both top and bottom mounting facilities. Connections are brought out as 10 inch flexible insulated wire leads with color coding.

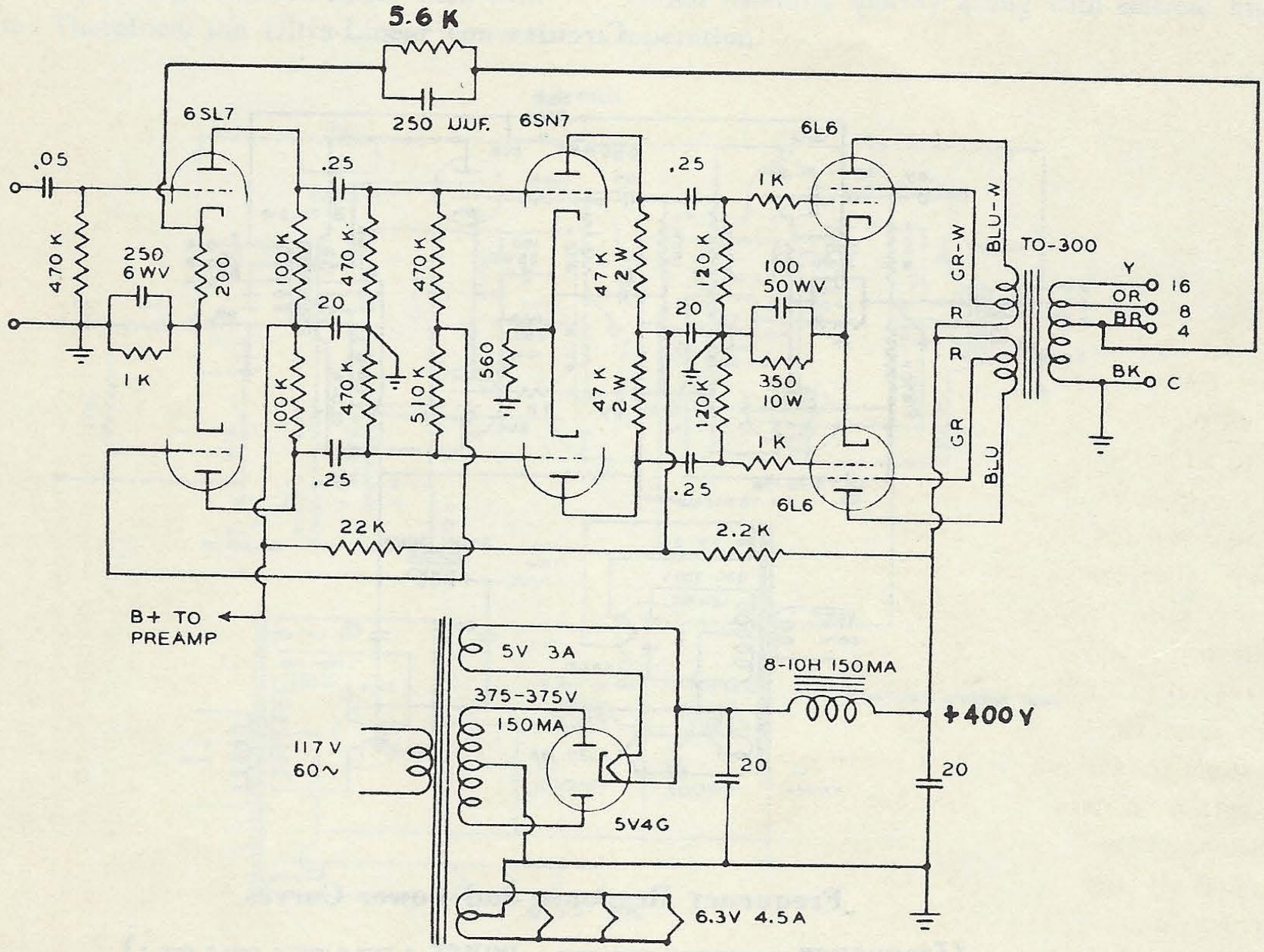


CONNECTIONS FOR "300" SERIES

ULTRA-LINEAR 6L6 AMPLIFIER

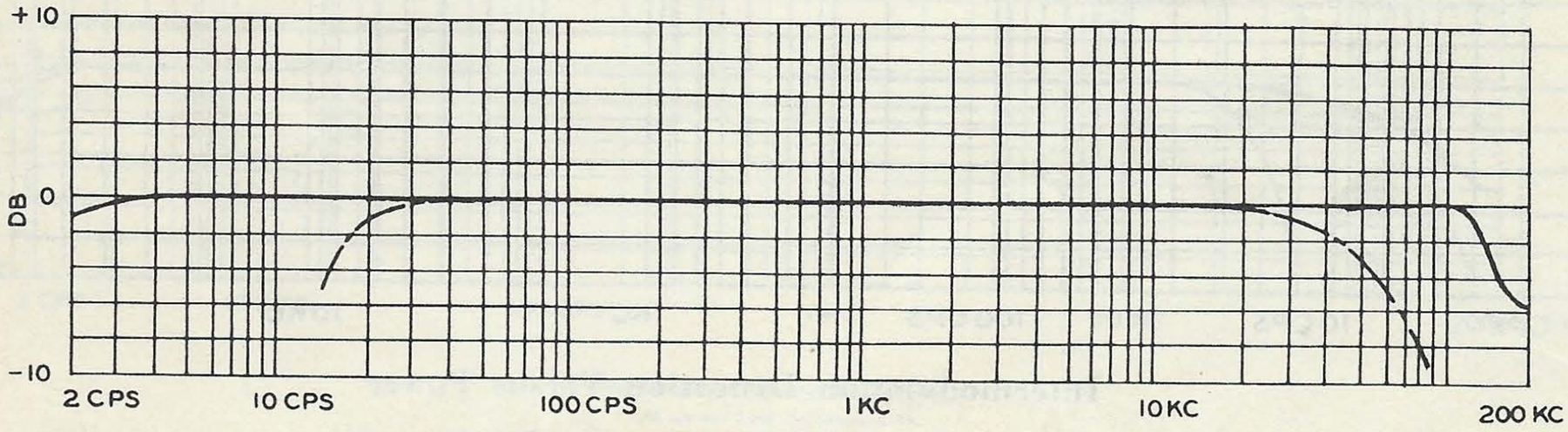
This circuit for 6L6's or 5881's was described in AUDIO ENGINEERING November, 1951. Its performance set a new standard of audio quality and has been widely acclaimed as one of the most important steps forward in audio design in recent years. The amplifier furnishes 20 watts of essentially undistorted audio with an input of only .7 volts.

Circuit



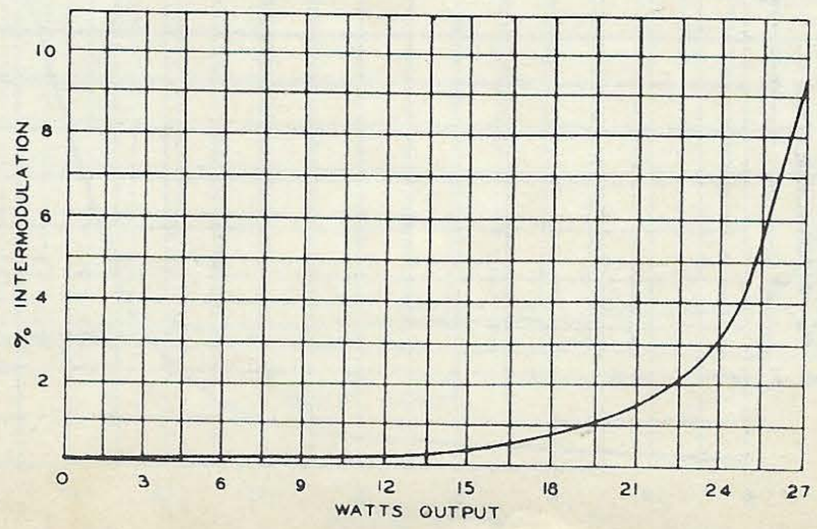
Frequency Response and Power Curves

(frequency ———— power - — - — - — - —)



Intermodulation Distortion Versus Power

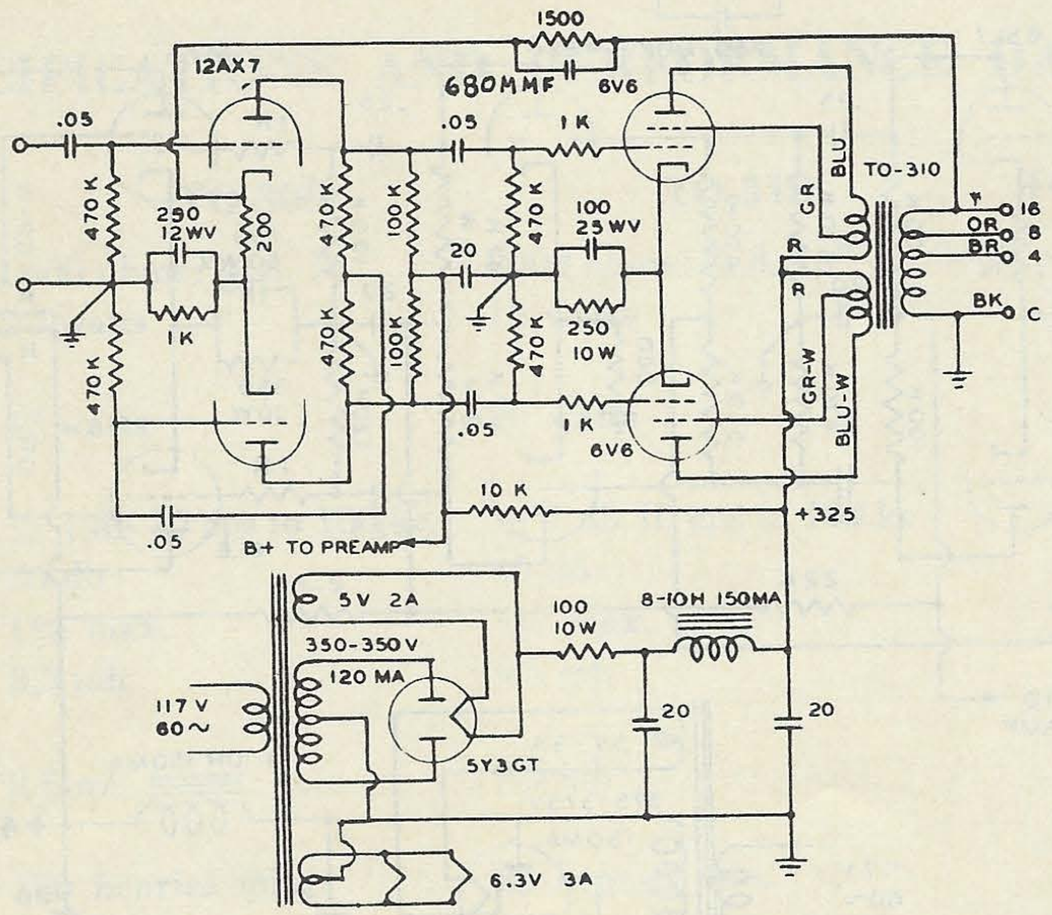
(40 cps and 2,000 cps mixed 4:1)



ULTRA-LINEAR 6V6 AMPLIFIER

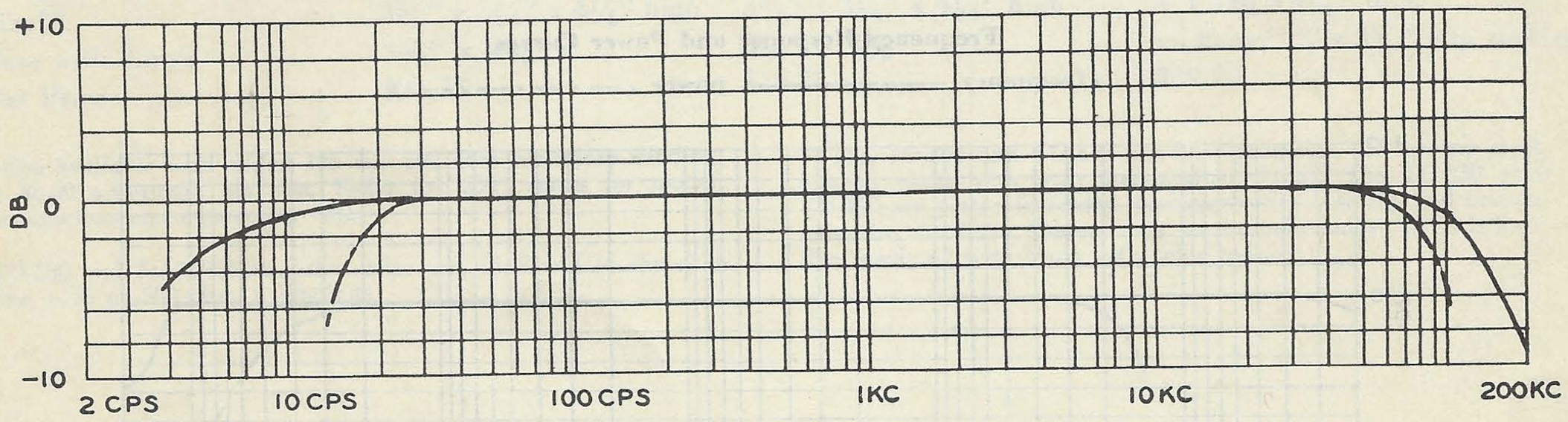
The Ultra-Linear "Junior" using the 6V6 type tube is an ideal amplifier for low power application. It furnishes 12 watts of audio with an input of 2 volts and is characterized by the superb listening quality of all Ultra-Linear circuitry. The basic configuration is similar to that utilized in many popular low cost commercial amplifiers, and one of the most common uses of the TO-310 transformer is for Ultra-Linear conversion of these amplifiers. This is perhaps the most economical and simple way to obtain a quality amplifier.

Circuit



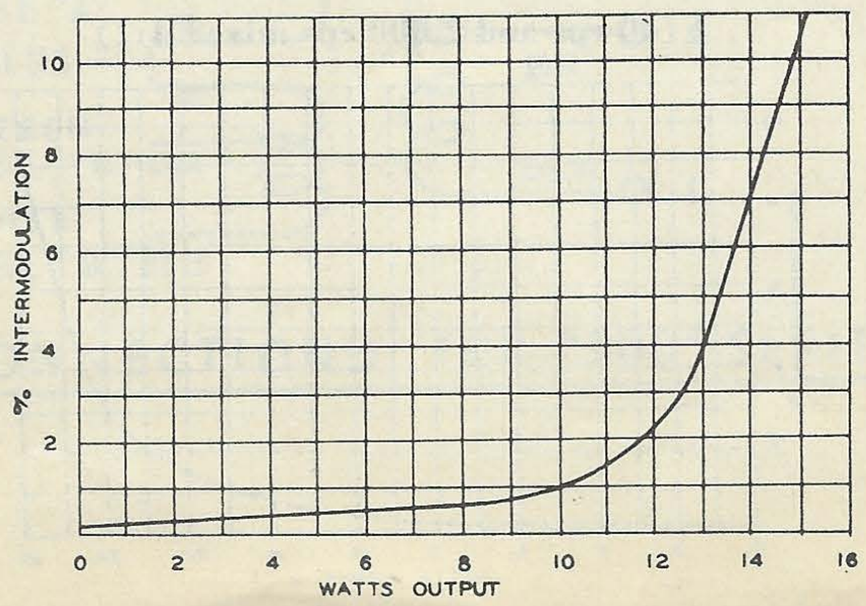
Frequency Response and Power Curves

(frequency ———— power - — - — - — - — -)



Intermodulation Distortion Versus Power

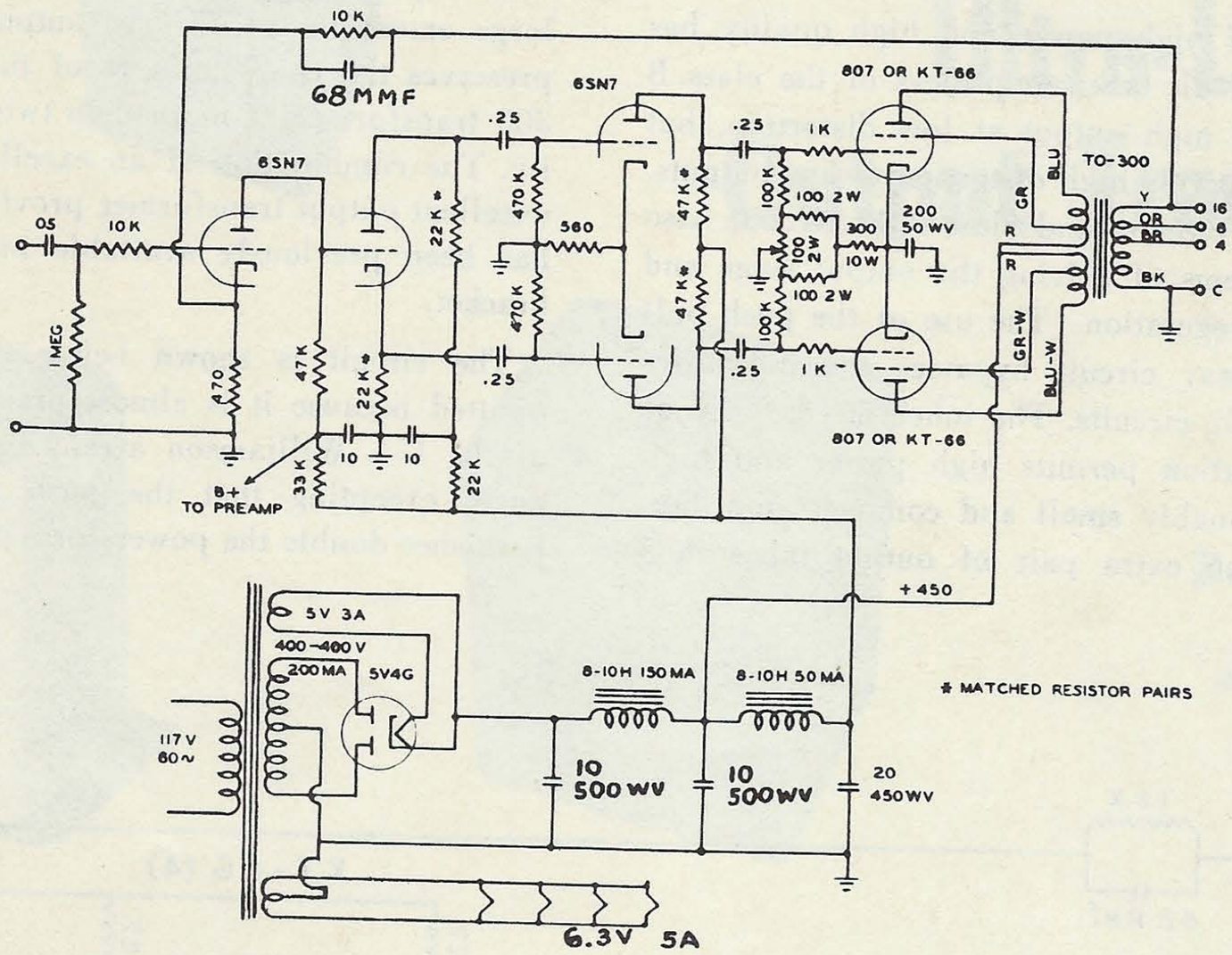
(40 cps and 2,000 cps mixed 4:1)



ULTRA-LINEAR OPERATION OF THE WILLIAMSON AMPLIFIER

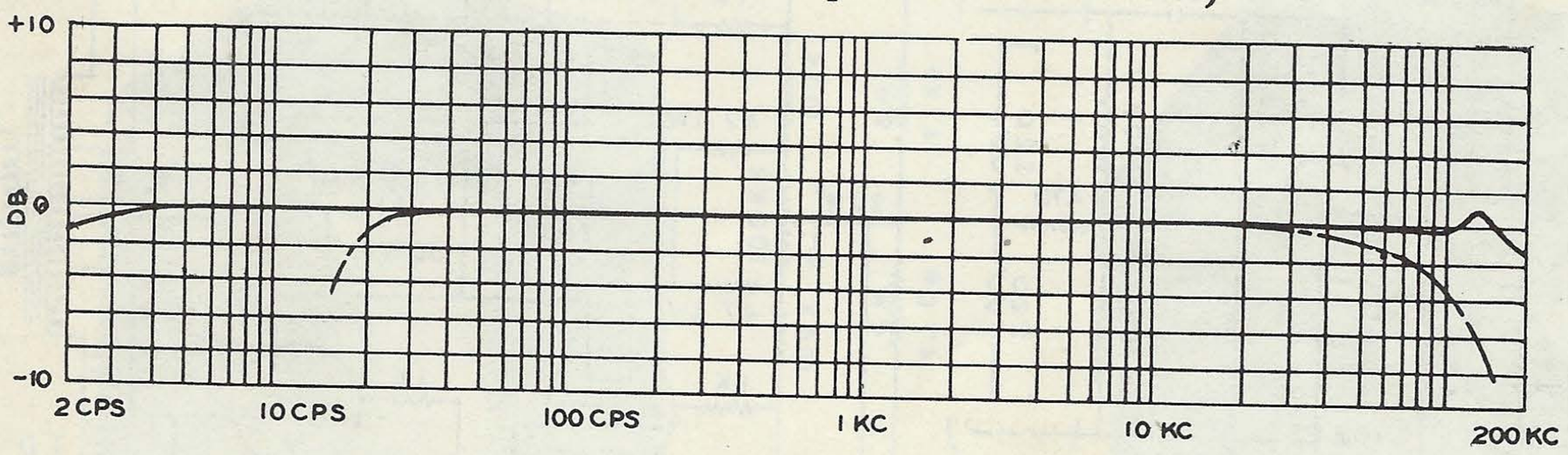
As described in AUDIO ENGINEERING June, 1952, the Williamson type amplifier can be readily converted to Ultra-Linear operation. This effectively doubles the power output, and distortion at almost all power levels is reduced. The characteristics of the TO-300 transformer surpass the original design specifications, and the output stage is more linear than with triode connection. Therefore, the Ultra-Linear conversion is an improved one in all respects. The circuit, as shown, is probably not subject to improvement in listening quality at the present state of the art. It now serves as the standard against which others are judged, and either those building initially or those converting existing circuits will find that the circuit offers unexcelled listening quality along with efficient high power operation.

Circuit



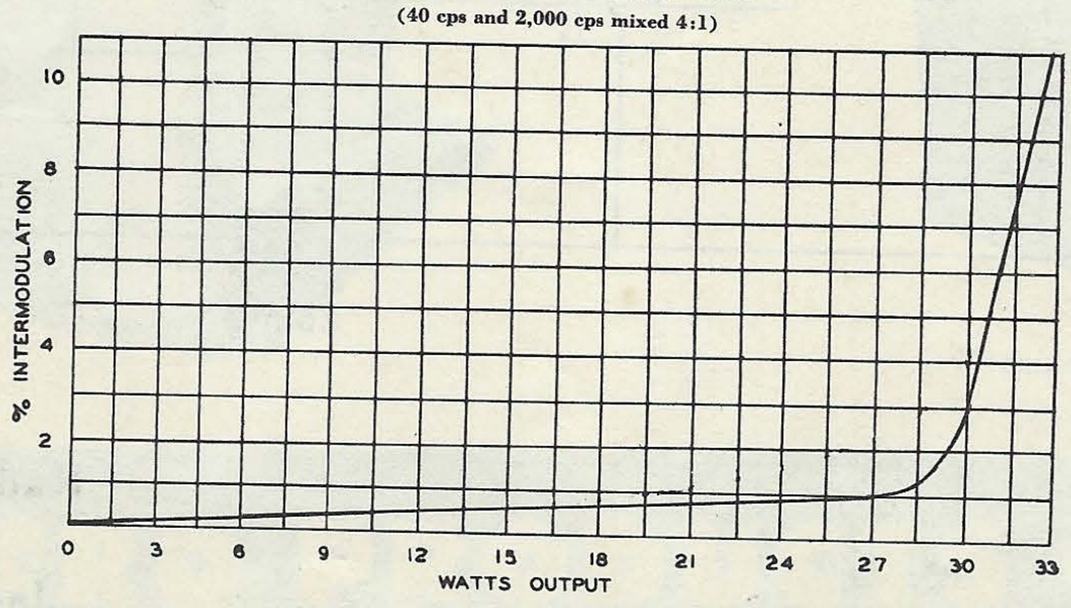
Frequency Response and Power Curves

(frequency ———— power - — - — - — -)



Intermodulation Distortion Versus Power

(40 cps and 2,000 cps mixed 4:1)



60 WATT PUSH PULL PARALLEL ULTRA-LINEAR AMPLIFIER

(based on Williamson Circuit)

There are many applications which require considerable power output while still maintaining a high degree of linearity. Even for home reproduction of music, many authorities feel that equipment should be designed to handle 50 watts or more so as to reproduce accurately a dynamic range equivalent to that which is found in the concert hall.

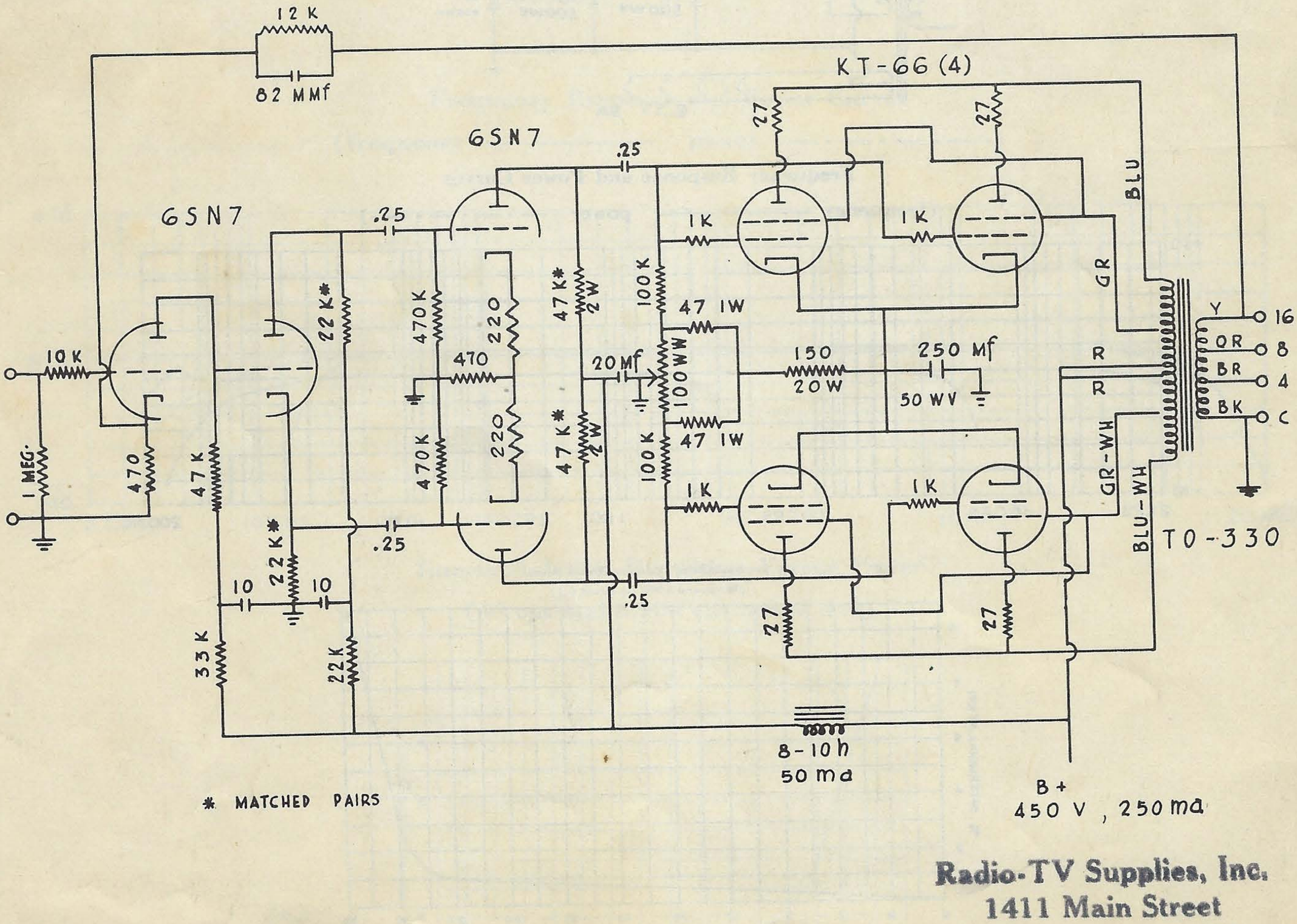
The blending of high power and high quality has always been a difficult task. Amplifiers of the class B type may produce high output at low distortion, but they may have relatively high distortion at low outputs. These over-biased circuits and class AB2 circuits also suffer from problems of driving the output stage and of power supply regulation. The use of the push pull parallel Ultra-Linear circuit bypasses the difficulties of class B and AB2 circuits. The inherent efficiency of Ultra-Linear operation permits high power and high quality in a reasonably small and compact amplifier, and the use of an extra pair of output tubes is a simple way of doubling the power of the basic U-L circuit arrangement.

The circuit shown below will provide up to 60 watts of undistorted power (less than 1% intermodulation distortion at 60 watts if well matched output tubes are used) along with the wide band pass and excellent transient characteristics of the Williamson type circuit.

The quality of this amplifier is attributable to a large extent to the TO-330 output transformer which preserves the characteristics of the world famous TO-300 transformer at more than twice its power capability. The combination of an excellent basic circuit and excellent output transformer provides better sound than has been previously available in such a high power bracket.

The circuit is shown below. Performance data is omitted because it is almost precisely parallel to that of the U-L Williamson arrangement of the preceding page, excepting that the push pull parallel circuit furnishes double the power for a given distortion.

CIRCUIT



Radio-TV Supplies, Inc.
1411 Main Street
Jacksonville 6. Florida
Phone 3-7353