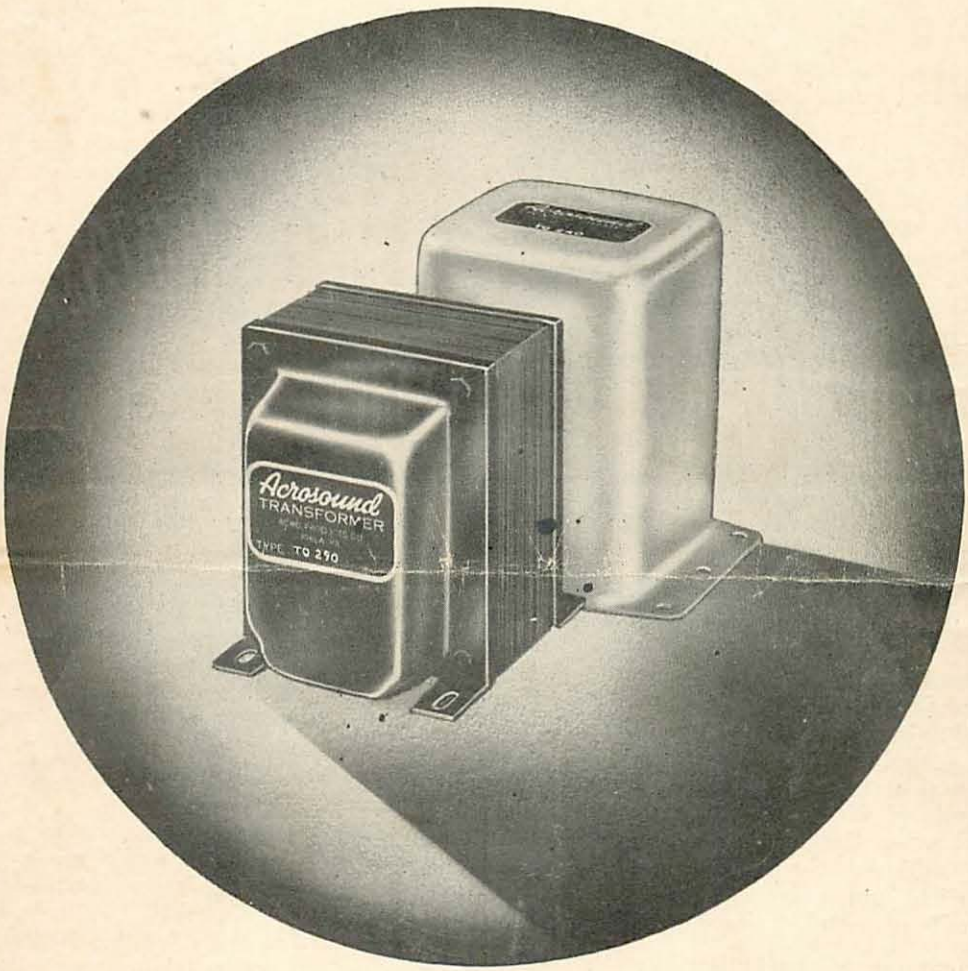
ACROSOUND



FINEST QUALITY

OUTPUT TRANSFORMERS

Patent Pending

ACRO PRODUCTS COMPANY • 369 SHURS LANE • PHILADELPHIA 28, PA.

Acrosound Output Transformers

Until such time as an amplifier can be coupled to a loudspeaker without the use of an impedance matching device such as a transformer, the output transformer will continue to be the single most important component in an audio amplifier. Obviously, the frequency range of the system cannot exceed that imposed by the transformer: the power capabilities cannot be greater than the transformer permits; the distortion cannot be lower than that inherent in the transformer; the overall fidelity must be bounded by the limitations set by this one critical item.

The ideal transformer must have many requisites. For push-pull design it must have extremely accurate reactive balance between the primary halves so as to maintain true out-of-phase operation throughout a very wide frequency band. Its inductance must be high even at low flux densities in order to provide full bass response even at the lowest volume levels. It must have sufficient core material to avoid saturation and consequent low frequency distortion and response droop at high levels. It must have low leakage reactance and close coupling to give full undistorted high frequency response. Lastly, its design should minimize phase shift so that degenerative feedback can be carried from secondary winding to an early stage in the amplifier without introducing instability even outside the useful audio range.

There can be no compromises with the above characteristics if high fidelity reproduction is the goal. The term "high fidelity" has many definitions, but when we of Acro Products Company speak of fidelity reproduction, we have one unequivocal meaning in mind — a high fidelity amplifier is one in which the signal at the input is reproduced at the output at any level within the power rating of the amplifier without noticeable change. This fidelity can only be achieved through use of an output transformer with unusually high capabilities and amplifier circuits of sound design.

It is a common misconception that the use of degenerative feedback will improve the characteristics of a transformer. This fallacious thinking is based on the idea that sufficient feedback will flatten the response curve and extend the frequency range of a transformer. Unfortunately, this is done at the expense of distortion, and it is simple to indicate how this happens.

First of all, when frequency response is limited and feedback is used, there is less voltage fed back at the points in the audio spectrum where response is down than at midfrequencies. At the edges of the pass band, the amplifier must deliver more power than at middle frequencies in the attempt to level the response curve. This has a serious consequence. For example, a 10 watt amplifier which is down 3db at 30 cps must deliver the same output voltage as would be necessary to produce 20 watts of power at 30 cps when feedback is used in an attempt to equalize the low frequency output. Even transformers which show flat response curves, do not necessarily deliver as much power at low and high frequencies as in the middle range. In fact, only the Acrosound transformers deliver *full* rated power at 20 cps. If the transformer is the cause of the original loss of low frequencies, it cannot possibly deliver higher output at those frequencies without a considerable rise in distortion. These considerations hold also for high frequencies, and thus, feedback around a transformer with limited response increases the low and high frequency distortion — just at the points where distortion is most noticeable and most irritating to the discriminating listener. The muddy bass and shrill treble which is characteristic of many amplifiers at high levels is directly attributable to this factor.

In addition, the same factors which cause limited frequency response are also the causes of excessive phase shift and limited power range. When phase shift is present in large degree, the signal fed back is *in* phase at some frequencies instead of 180 degrees out-of-phase. Therefore, only a small proportion of feedback can be used before motorboating or squealing is experienced. The benefits of feedback cannot be fully realized in that case. It is impractical to attempt to use the amplifier with the maximum feedback — the threshold beyond which instability appears. If this is attempted, transient instability occurs, and the amplifier distorts under dynamic conditions even though its steady state measurements may seem satisfactory.

It may seem surprising that even though the critical frequency band for audio use extends from 30 cps to 15 kc, it is necessary for the output transformer to pass a band essentially flat from 10 cps to 40 kc. One of the reasons for this is the necessity for feedback even with triode amplifiers if really high fidelity is sought. The wide transformer range minimizes distortion at the edges of the effective audio spectrum when feedback is used. Then too, inaudible high frequencies will beat together in the ear to produce audible beat notes. This factor adds "presence" to musical reproduction which has inaudibly high overtones that indirectly contribute to audible realism in reproduction.

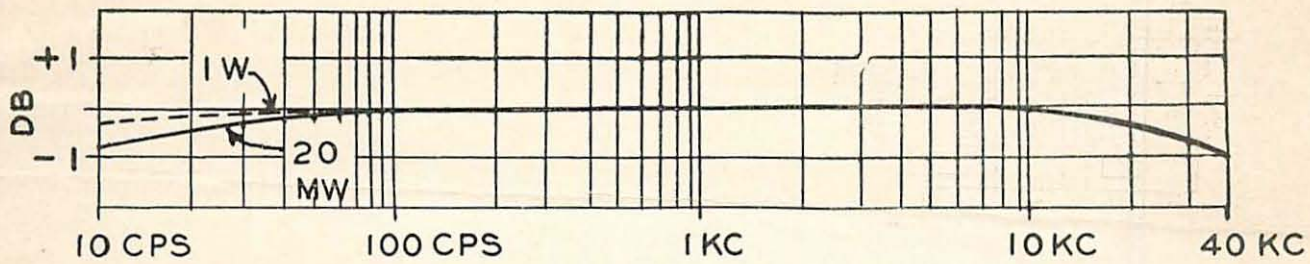
Another justification for wide frequency range is that it goes hand in hand with low phase shift. When excessive phase shift is present, it disturbs the harmonic structure of complex sounds and consequently changes the attack and decay time with resultant loss of fidelity under conditions of dynamic operation.

For all of the above reasons, even though speakers cannot reproduce the supersonic or subsonic regions, nor can the ear hear them, they must be represented in order to achieve high fidelity. Amplifiers can be built to present a wide band to the output transformer. It is the transformer which has always been the stumbling block to optimum reproduction. Even the transformers which claim response from 20 cps to 20 kc may have a fairly sharp cutoff at each end of this range so that feedback difficulties are encountered. In addition, their power handling capabilities generally start to droop at 100 cps and 10 kc or even less. This latter difficulty means that at high levels, or when bass or treble boost are used, the distortion is high within the critical range.

For years there has been need of a really outstanding output transformer. The first Acrosound transformers were designed with the objective of obtaining high fidelity regardless of cost. A truly outstanding unit was evolved which was satisfactory for the most critical laboratory work. However, it was realized that for most professional uses, and particularly for home use, there was definite need for a unit that could be mass produced at a reasonable cost. Present prices of high fidelity transformers are high and discourage their use. There is a demand for a modest cost item which is better than any commercially available.

Naturally, in a competitive market every manufacturer has been seeking quality at reduced costs. This new Acrosound series has reached that goal at the culmination of more than two years of development research in which new principles of transformer design were invoked. These transformers represent a radical departure from conventional designs and feature a symmetric coil structure that provides a new high in performance. No sacrifices have been made in quality, but the new design in conjunction with a policy of utility styling without unnecessary frills, has permitted prices within the reach of all audio enthusiasts, both engineers and experimenters who desire the best.

FREQUENCY RESPONSE



Above is the frequency response curve of an average transformer of this series. This curve was measured with the transformer matched in rated primary and secondary impedances. The transformer response can be further extended several octaves in each direction through the use of degenerative feedback. Therefore, it is obvious that these units lend themselves to any applications calling for an exceptionally wide band width. Further it can be seen that the response is still excellent even at as low a level as 20 milliwatts, the lowest listening level commonly used.

In addition to this outstanding frequency response, the Acrosound transformers feature the following characteristics:

POWER CAPACITY is rated at 20 cps, and all units deliver *full* rated power over the 20 to 20,000 cps band. This conservative rating should not be interpreted as a maximum rating. Actually, the transformers will handle double the rated power throughout the middle frequency range.

PHASE SHIFT is sufficiently low to permit over 30 db of degenerative feedback to be carried *around* the transformer without instability. The principle limitation on the permissible amount of feedback is not the output transformer, but the number of stages and the phase shift in the interstage coupling networks.

TRANSIENT RESPONSE is excellent as determined by the negligible distortion of a 20kc square wave passed through the transformer.

MODELS

12.5 Watts (approximate weight 5 lbs.)

TO-240	4,000 ohms....	net cost $9.75
TO-250	5,000 ohms....	net cost $9.75
TO-260	6,000 ohms....	net cost $9.75
TO-270	10,000 ohms....	net cost $9.75

25 Watts (approximate weight 6 lbs.)

TO-230	3,000 ohms....	net cost $12.50
TO-280	9,000 ohms....	net cost $12.50
TO-290	12,000 ohms....	net cost $13.75

(Prices Effective October 15, 1950 and Subject to Change Without Notice)

All units have push pull primaries and secondaries tapped for 4, 8, and 16 ohm voice coils. Other primary impedances and different power ratings can be furnished to special order. Prices will be quoted on special items on request. Line windings (125 and 500 or 150 and 600 ohms) can be added to all units at an additional $6.00 net cost.

Units have 10 inch leads color coded as indicated in schematics shown on following page.

Above prices are for units in standard end bells. At an additional net cost of $2.00 per unit, the transformers can be furnished fully potted in a seamless steel case in silver gray hammertone finish.

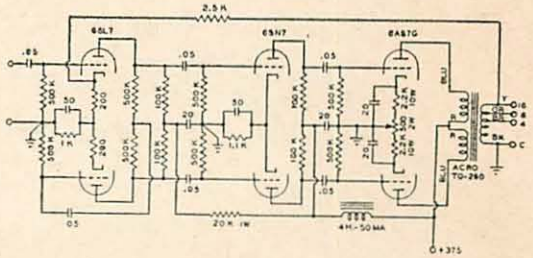
Please Note: Temporarily only potted units are available and these are supplied on all orders.

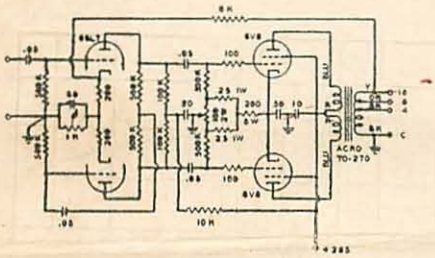
Suggested Circuits

These circuits illustrate some applications of this new line of transformers. They are all bug-free, and they provide a standard of performance which is difficult to excell. The response of these amplifiers is substantially flat from below 5 cps to over 80 kc. Within the 20 cps to 20 kc range, they will deliver full output with undetectable harmonic or intermodulation content. On measurements of all types they show up amazingly well, and in addition they will satisfy the subjective listening of the most critical observer. These are not the only circuits which could be used, of course. Any wide range, low distortion circuit which is basically stable and has balanced push pull stages will perform equally well with Acrosound output transformers.

TO-260

The potentially excellent 6AS7 has been shunned by many constructors because of the difficulties of driving it without an interstage transformer. In this circuit, the push pull driver and the application of inverse feedback permit ample output at low distortion levels.



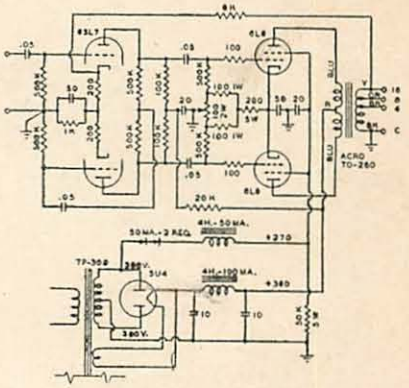


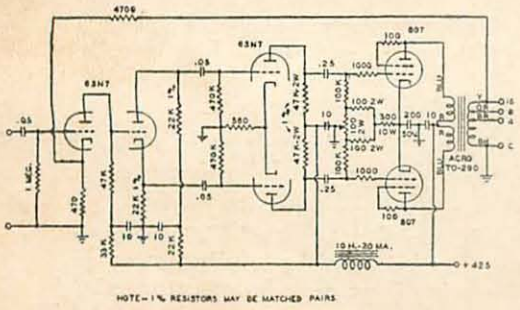
TO-270

The 6V6 offers excellent fidelity at moderate cost in this circuit configuration. The phase inverter used provides close balance throughout the entire audio band along with substantial gain. For the small number of parts used, the fidelity of this amplifier can hardly be surpassed.

TO-280

For those who prefer beam power output tubes, this 6L6 circuit offers excellent possibilities for high fidelity along with greater efficiency than triodes permit. An ingenious method of supplying the screens from a low impedance source with good regulation is an important factor in the excellent performance obtained.





TO-290 Williamson Circuit

This circuit is that designed by D. T. N. Williamson and described in Wireless World (August, 1949). This version has been adapted to use American components; but aside from the approximate 12 watt limitation on undistorted power, it realizes the full capabilities of the original circuit which has been universally acclaimed as one of the best ever heard.

Acrosound ★

Ultra Linear Circuitry

*Patent Pending

Ultra Linear circuits are a new development of Acro Products Company and are designed to provide both the finest listening quality and the finest measurements available. Their unique features are obtained by two important circuit elements: 1. an Ultra Linear output stage which is neither triode nor tetrode but combines the advantages of tetrode efficiency and power sensitivity with triode low impedance and has lower distortion than either of these two types; 2. an output transformer superior to any design yet offered to the public with respect to linearity of response and low distortion.

The output stage of Ultra Linear circuits uses the flow of screen current in the output transformer to control screen dissipation. This permits higher than normal screen and bias voltages without detrimental effects; and the mixing of screen and plate current in controlled proportion decreases distortion, lowers output impedance, increases tube linearity, and preserves both the efficiency and sensitivity that would be sacrificed by conventional feedback arrangements.

A great many circuit arrangements can be used with Ultra Linear output stages and Acrosound transformers. In order to obtain the ultimate in listening quality, it is, of course, necessary to prefix the output stage with a high quality low distortion circuit. The complete amplifier must be designed so as to be completely and unconditionally stable with a high proportion of inverse feedback. Two extremely satisfactory arrangements are shown in this pamphlet.

One arrangement uses 6L6's (or 5881's) and furnishes 24 watts of clean power. The other is a simpler and less expensive arrangement which provides 12 watts with 6V6's in the output stage, and it is an arrangement to which many popular commercial circuits can be converted readily.

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.

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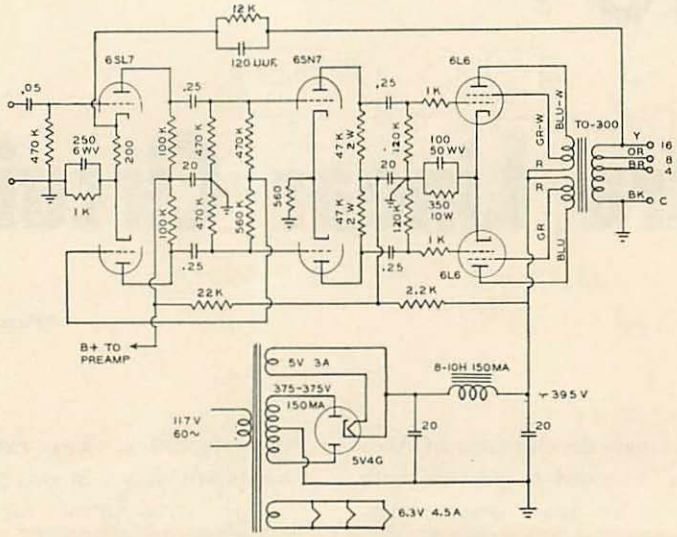
THE ACROSOUND ULTRA LINEAR AMPLIFIER

This amplifier (described more fully in AUDIO ENGINEERING, November, 1951) is a deluxe circuit offering linearity of response and low distortion of an order never previously achieved in practical circuits which could be built by the home constructor. It is driven to full 24 watt output with an input of only three-quarters of a volt and thus can be fed from any conventional input source.

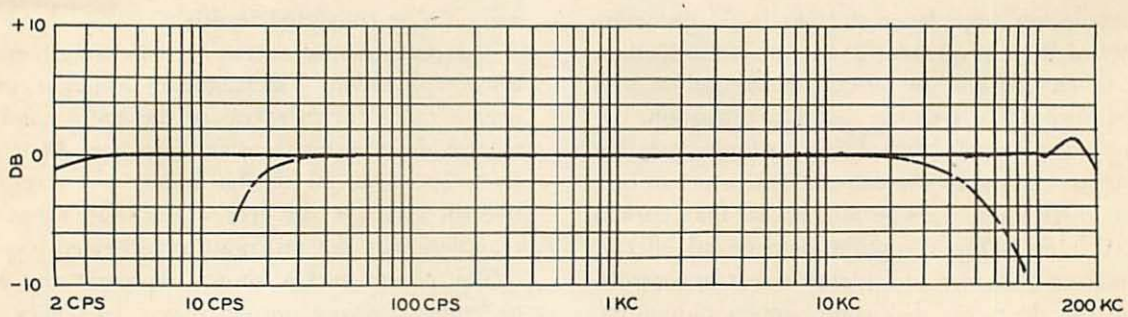
Circuit



Note: One side of filament should be grounded at lowest level stage.

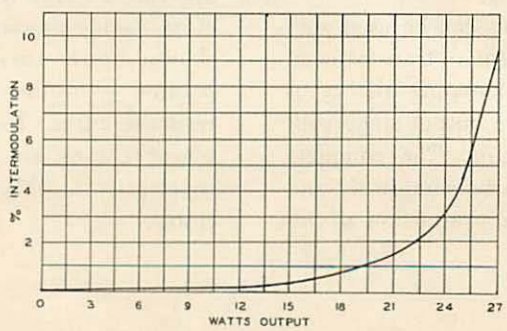
Frequency Response and Power Curves

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



Intermodulation Distortion Versus Power

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



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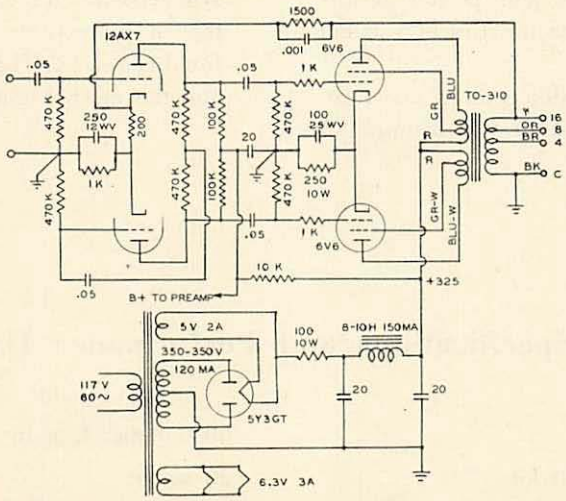
THE ULTRA LINEAR JUNIOR AMPLIFIER

For those whose needs are satisfied by a lower power circuit, the Ultra Linear Junior offers 12 watts in an economy circuit which is characterized by the superlative listening quality of all Ultra Linear circuitry. This amplifier drives to full output with a two volt input and is of a circuit configuration which makes it adaptable to conversion of many popular circuits by the addition of the Acrosound TO-310 transformer along with a few minor circuit changes.

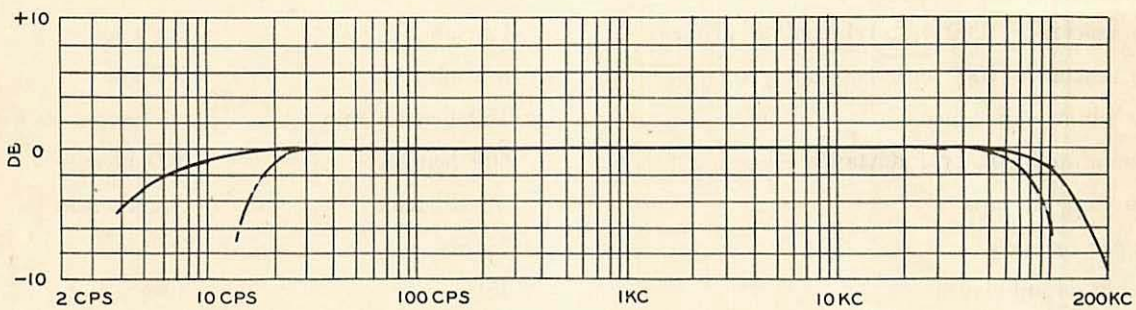
Circuit



Note: One side of filament should be grounded at lowest level stage.

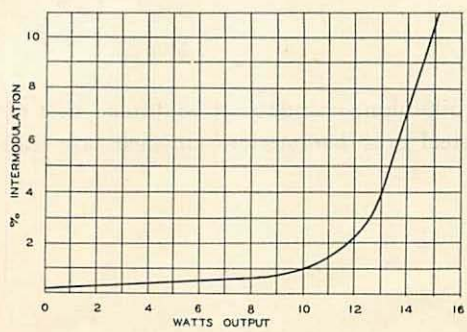
Frequency Response and Power Curves

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



Intermodulation Distortion Versus Power

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



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ACROSOUND "300" SERIES TRANSFORMERS

(tapped for use in Ultra Linear Circuits)

These transformers are the finest ever offered to the public. They impose practically no limitation on the quality of the associated circuit and permit results limited only by the inherent characteristics of vacuum tubes.

The excellent frequency, distortion, power, and transient characteristics of these units are a triumph of design art and production skill. The use of the finest materials and a unique seven section concentric symmetrical coil structure permit size which is half that of competitive units while the specifications speak for themselves. They offer the most quality per pound and the most quality per dollar simultaneously.

Specifications and Performance Data

	TO-300	TO-310
Impedance*	6600 ohms: 4, 8, 16	8000 ohms: 4, 8, 16
Undistorted power—20 cps to 30 kc	20 watts	10 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
Max dc per primary	75 ma	75 ma
Permissible dc unbalance	15%	15%
Weight	6 lbs.	5 lbs.
Size**	3⅝" x 3¼" x 4¼" high	3⅝" x 3¼" x 4¼" high
Base with flange	3⅝" x 4½"	3⅝" x 4½"
Net Price	$24.75	$18.75

*Also available with added 125 and 500 ohm secondary at additional cost of $6.00 net.

**All units fully potted in seamless steel gray hammertone finished case with 10" color coded leads.

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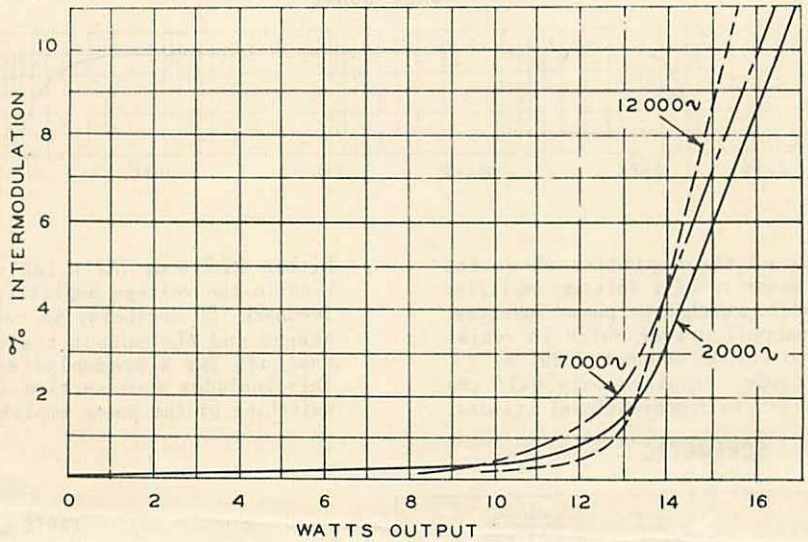
THE ACROSOUND ADAPTATION OF THE WILLIAMSON CIRCUIT

International acclaim of the famous circuit of D.T.N. Williamson (Wireless World, April and May, 1947; August, 1949) has led to its adaptation in many forms. The Acrosound version was designed to maintain all of the quality of the original circuit while constructing it of American components.

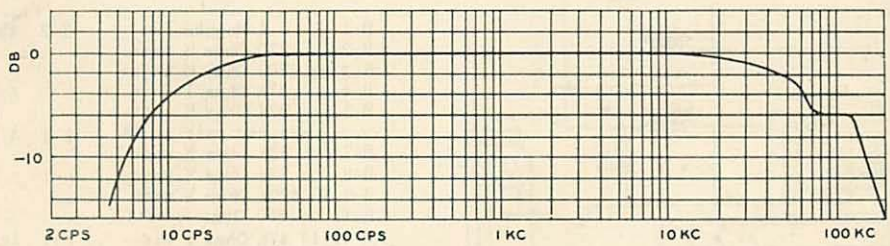
The Acrosound TO-290 transformer is the heart of this fine amplifier. This unit was tailored specifically for the circuit just as was the transformer specified by Williamson. The TO-290 uses 12,000 ohms primary impedance to obtain the same ratio of primary impedance to plate resistance when using triode connected 807 tubes as Williamson used with the British KT66 tubes.

INTERMODULATION VS. POWER



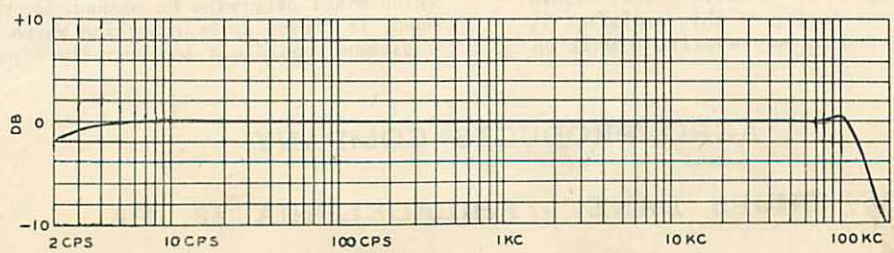
The intermodulation curves are shown above with 40 cycle carrier mixed four to one. The IM is less than 1% at 11 watts output under any condition of measurement. At 15 watts, the amplifier reaches conventional IM ratings of about 8%. Obviously, for all normal uses in a home, where several watts constitute maximum necessary power, the distortion is truly low.

FREQUENCY RESPONSE WITHOUT FEEDBACK



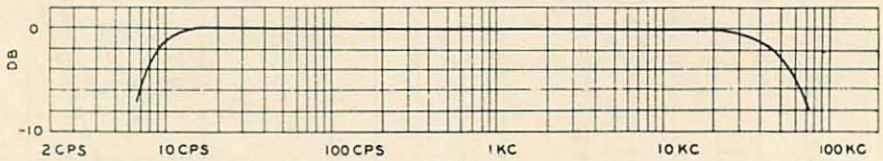
Extremely interesting performance data are revealed by the curves on frequency response and power. Response <u>without</u> feedback is better than that of most commercial amplifiers. With feedback, frequency response is flat from 7 cps to over 70 kc with substantial response outside those limits. There are no high frequency resonances or peaks indicative of instability, ringing, or other forms of transient distortion.

FREQUENCY RESPONSE WITH FEEDBACK



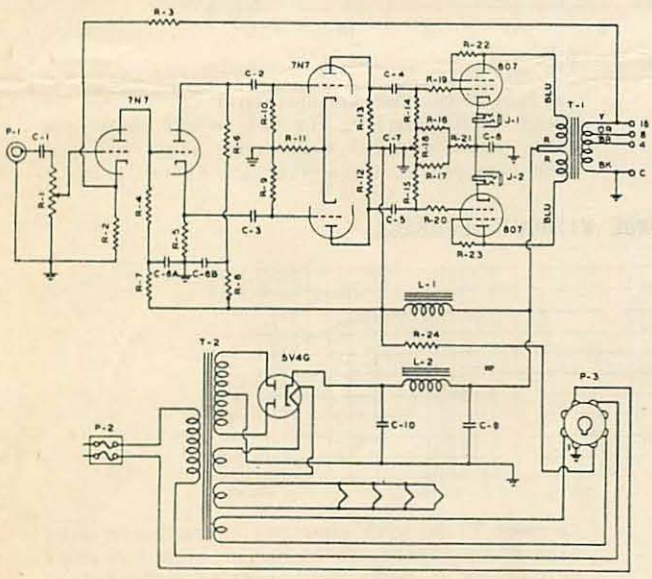
The power curve is truly phenomenal. This is not a response curve run at high power level (which would be similar to the above frequency curves if distortion is ignored). The power curve shown represents maximum undistorted power available across the band. The curve is run by observing the maximum signal on the 'scope which shows no visual distortion. In the midband, this is 12.5 watts. At the ends of the band, the input voltage has to be reduced slightly to maintain the undistorted condition. The curve shows the exceptional performance obtained -- power is down only 3 db at 8 cps and 51 kc. To our knowledge, no other transformer will permit such performance.

POWER CURVE



The schematic of the amplifier shows its simplicity. It consists of a voltage amplifier directly coupled to a cathodyne phase inverter. This feeds a pushpull driver which is resistance coupled to triode connected 807's. The 807 as a triode, requires only half the grid drive necessary with conventional triodes. Either 6SN7's or 7N7's (as indicated) can be used in the voltage amplifier stages. Inverse feedback (20 decibels) is carried around four stages and the output transformer. A power take off for a preamplifier is shown also. This includes a connection for remote on-off switching of the power amplifier.

SCHEMATIC



PARTS LIST

C-1,2,3	.05 uf. 600 WV
C-4,5	.25 uf. 600 WV
C-6	10-10 uf. 450 WV
C-7	20 uf. 450 WV
C-8	500 uf. 50 WV
C-9	20 uf. 450 WV
C-10	4 uf. 600 WV
R-1	1 Megohm pot
R-2	470 Ohms ½ watt
R-3,24	4700 Ohms ½ watt
R-4	47K Ohms 1 watt
R-5,6	22K Ohms ½ watt-matched pair or 1%
R-7	33K Ohms ½ watt
R-8	22K Ohms ½ watt
R-9,10	470K Ohms ½ watt
R-11	560 Ohms ½ watt
R-12,13	47K Ohms 2 watt-matched pair or 1%
R-14,15	100KOhms ½ watt
R-16,17 22,23	100 Ohms 1 watt
R-18	100 Ohms 2 watt-wirewound pot
R-19,20	1000 Ohms ½ watt
R-21	300 Ohms 10 watt
T-1	12 000 Ohms/4,8,16 Ohms Acrosound TO-290
T-2	425-425 volts 130 ma. Acrosound TP-310
	6.3 volts, 3.5 Amp.
	6.3 volts, 3.5 Amp.
	5 volts, 3 Amp.
L-1	4 henry, 50 ma. choke
L-2	8 henry, 150 ma. choke
P-1	Input Plug Amphenol 80c.
P-2	Fused line plug
P-3	Octal socket

The final test of any amplifier is in its listening. No measurements will reveal the final nuances of fidelity, particularly on material with transients. We believe that within the ten watt power rating of this amplifier it cannot be exceeded by any available unit on the basis of listening comparisons. The only drawback which one might find is that it will reveal distortion in other parts of the system which might otherwise be masked. On the other hand, it cleans up reproduction which on other equipment could not be properly reproduced.

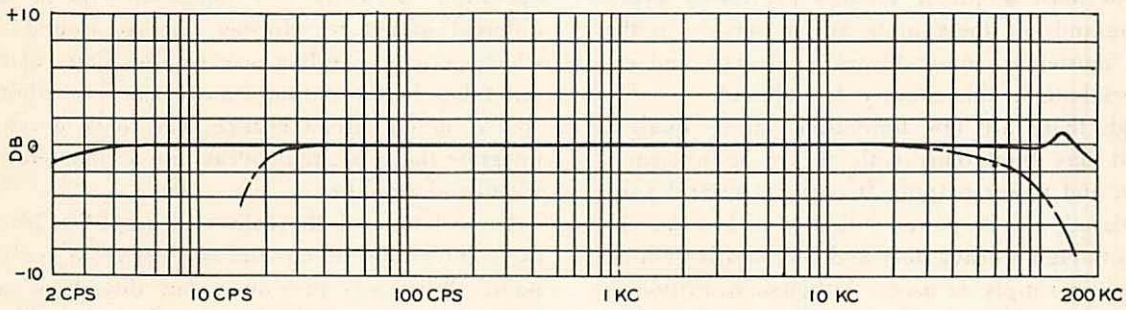
ACRO PRODUCTS COMPANY

369 SHURS LANE - PHILADELPHIA 28, PA.

The power curve is of particular interest. It indicates the maximum power output versus frequency. Ample undistorted power is available far into the ultrasonic region. Frequency response extends plus or minus one decibel for a range extending ten times above and below the customary audio band, thus insuring minimum distortion of steep fronted transients.

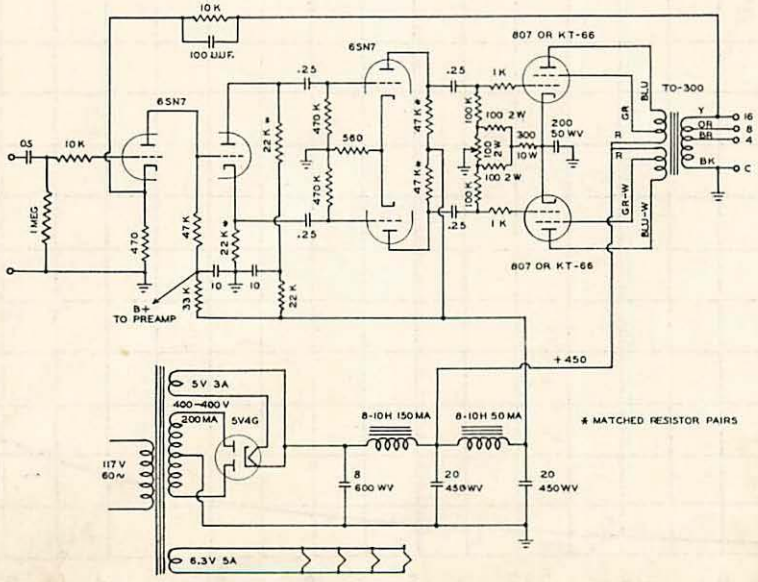
Frequency and Power Curves

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



The circuit of the amplifier shows how little change is needed to convert the Williamson arrangement. The power supply is unchanged, and the changes involve a few resistors and capacitors with no change in physical layout. The feedback resistor is changed to maintain 20 db of feedback, and the amplifier now is driven to 30 watts with approximately 1 volt of input. The changes are so few and, with the exception of the output transformer, so inexpensive that conversion is feasible for many who wish to obtain the benefits of Ultra Linear operation in existing equipment. For those who are building from scratch, the circuit offers tremendous inducement from the standpoint of unexcelled listening quality along with efficient high power operation.

Circuit



Note: One side of filament should be grounded at lowest level stage.

THE ULTRA LINEAR WILLIAMSON AMPLIFIER

The American version of the Williamson amplifier using the Acrosound TO-290 transformer and described in RADIO and TELEVISION NEWS for December, 1950 has provided audio quality which is indisputably superior to most amplifier circuits previously available. Thousands of these units are in service in the homes of musicians, music lovers, engineers, and experimenters both in this country and abroad.

Although there are few limitations on its quality, the circuit has limitations with regard to efficiency, sensitivity, and power output. It requires several volts of input signal, and its power is limited to less than 15 watts even though a heavy duty and comparatively high voltage power supply is used. Although distortion is at the vanishing point at low levels, and IM is less than 1% at 10 watts, above this power level distortion increases rapidly.

There is definite need for a higher power more efficient version of this circuit; and this need has not been met too well by pushpull parallel configurations which do not, of course, increase the efficiency of the circuit.

The development of the Ultra Linear output stage arrangement immediately suggested the possibilities of adapting the Williamson circuit so as to get the increased efficiency along with the increased linearity of operation. Basically, this change calls for the use of a different output transformer, the Acrosound TO-300, which permits coupling screens and plates of the output tubes in the output transformer. In addition, of course, minor circuit changes had to be developed to integrate the two circuit ideas into a completely stable wide band amplifier.

Careful tests of the converted amplifier reveal that the combination of circuits is ideal from every standpoint. What was previously low distortion has been reduced to where it is almost not measureable. Band width has been increased and smoothed, and the transient and square wave response consequently has been improved. These results are indicated on the intermodulation, power, and response curves which are shown. The IM indicates that the amplifier power has been effectively doubled.

Intermodulation Distortion Versus Power
(40 cps and 2,000 cps mixed 4:1)